PALÆONTOGRAPHICAL SOCIETY.

# BRITISH FOSSIL ECHINODERMATA.

PART SECOND.

THE DIADEMADÆ, ECHINIDÆ, SALENIADÆ, AND ECHINOCONIDÆ.

# FOSSIL MALACOSTRACOUS CRUSTACEA.

OF

GREAT BRITAIN.

PART I.

CRUSTACEA OF THE LONDON CLAY.

# BRITISH PERMIAN BRACHIOPODA.

PART IV.

# BRITISH CARBONIFEROUS BRACHIOPODA.

PART V.

# FOSSIL REPTILIA

OF THE

WEALDEN FORMATION.

PART IV.

ISSUED FOR 1856.

California Academy of Sciences

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Geology
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# SUPPLEMENT

TO THE

# EOCENE CHELONIA.

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## Emys Conybearii, *Owen*. T. XIII and XIV.

The subject of the present description is the most complete specimen of fossil fresh-water Tortoise (*Emys*) which has hitherto come under my observation. It was obtained, like the *Emys Delabechii*, Bell, which it most resembles, from the Eocene clay of Sheppey Island, and forms part of the large and instructive collection of Sheppey fossils belonging to J. S. Bowerbank, Esq., F.R.S. It consists of both carapace (T. XXVIII *A*), and plastron (T. XXVIII *B*), giving the natural curves, depth, and periphery of the portable abode of the animal. Every constituent bone of the complex roof of this abode is preserved, and the impressions of every horny scute can be traced, uninterruptedly, upon its uninjured surface. The floor or "plastron" is, unfortunately, not so entire, but its margins are unbroken, exhibiting the characteristic contour.

The dimensions of this noble specimen of Eocene *Emys* fall little short of those of the *Emys Delabechii*, the length of the carapace being 1 foot 6½ inches, and its breadth 1 foot 3 inches.

The forms and proportions of the nuchal (*ch*), pygal (*py*), and their connecting series of median neural plates (*s* 1 to *s* 9), are accurately shown in T. XXVIII *A*: the eighth neural plate is obliterated, or has its place taken by the extension of ossification of the seventh and eighth costal plates towards the median line. The abraded and fractured state of the carapace of *Emys Delabechii** does not permit of a comparison of this particular.

There is no trace of a median elevation or keel in *Emys Conybearii*: the neural plates in *Emys bicarinata*† are broader in proportion to their length than in the present species, and the series is not interrupted.

* 'Monograph on Fossil Reptilia of the London Clay,' T. xxviii, Palæontographical Memoirs for 1848.

† Ib., T. xxv.

In the costal plates (T. XXVIII *A*, *pl* 1—*pl* 8) the general form and proportions are sufficiently clearly represented; but it is worthy of special remark that the first (*pl* 1) has a small quadrate portion marked out on its inner or median border, by the impression of a supplementary median scute, which I have not observed in other Emydians, recent or fossil; and should that supplementary scute be constant in the present species, such species might be indicated by a detached fossil first costal plate (*pl* 1).

In Emydians generally the vertebral scutes are five in number; the costal scutes are four pairs: collectively, when they have been called "discal" scutes or plates, thirteen is the number. In the present extinct species they were fourteen in number, owing to the division of the first vertebral scute (*v* 1), or to the interposition of a small transversely extended quadrate scute between it and the second vertebral scute (*v* 2). It will be fortunate if other specimens of the *Emys Conybearii* should show this character to be a constant one.

In *Emys Delabechii* the carapace is unluckily mutilated at the part requisite for determining whether the supplementary median scute existed. The second vertebral scute (*v* 2) in *Emys Delabechii* is as broad as it is long: in *Emys Conybearii* the breadth of the same scute is one third greater than its length. A similar difference of proportions, with more produced and acute lateral angles, characterises the third vertebral scute of *Emys Conybearii* as compared with *Emys Delabechii*.

The fourth vertebral scute in *Emys Conybearii* has the front half of its lateral margin wavy or crenate, not a simple sigmoid line, as in *Emys Delabechii*. The breadth and depth of the scutal impressions are alike in both species.

In *Hydromedusa* the number of discal scutes, or those inclosed by the marginal scutes, is fourteen, as in the present fossil; and, as it appears to me, by a similar transverse division of the first vertebral scute; only the dividing line crosses the scute more anteriorly, so that the proportions of the front and hind divisions are reversed. Dr. Gray regards the front division as the homologue of the front marginal scutel called "nuchal" in other *Chelydidæ* and in *Emydidæ*, and characterises *Hydromedusa* as having "the nuchal plate large, placed behind the front marginal plate, like a sixth vertebral;" but if the carapace of *Hydromedusa depressa** be compared with that of *Chelodina oblonga*,† and *Sternothærus Derbianus*,‡ the marginal series of scutes will be seen to be similar in number in the two species, and their condition to be essentially that which is defined in the characters of *Sternothærus*, as "Nuchal plate none."§ The part called "nuchal plate" in *Hydromedusa depressa* answers to the front part of the first vertebral plate in *Sternothærus* and *Chelodina*: the different position of the dividing line in the *Emys Conybearii* more strongly marks the true homological character of the first of the median series of discal scutes. I conclude, therefore, that, as in

* 'Catalogue of Shield Reptiles,' Brit. Mus., 4to, p. 59.

† Ib., tab. xxvi. ‡ Ib., tab. xxii. § Ib., p. 51.

*Sternothærus* and *Hydromedusa*, the nuchal scute is absent in *Emys Conybearii*, the number of marginal scutes being 12—12.

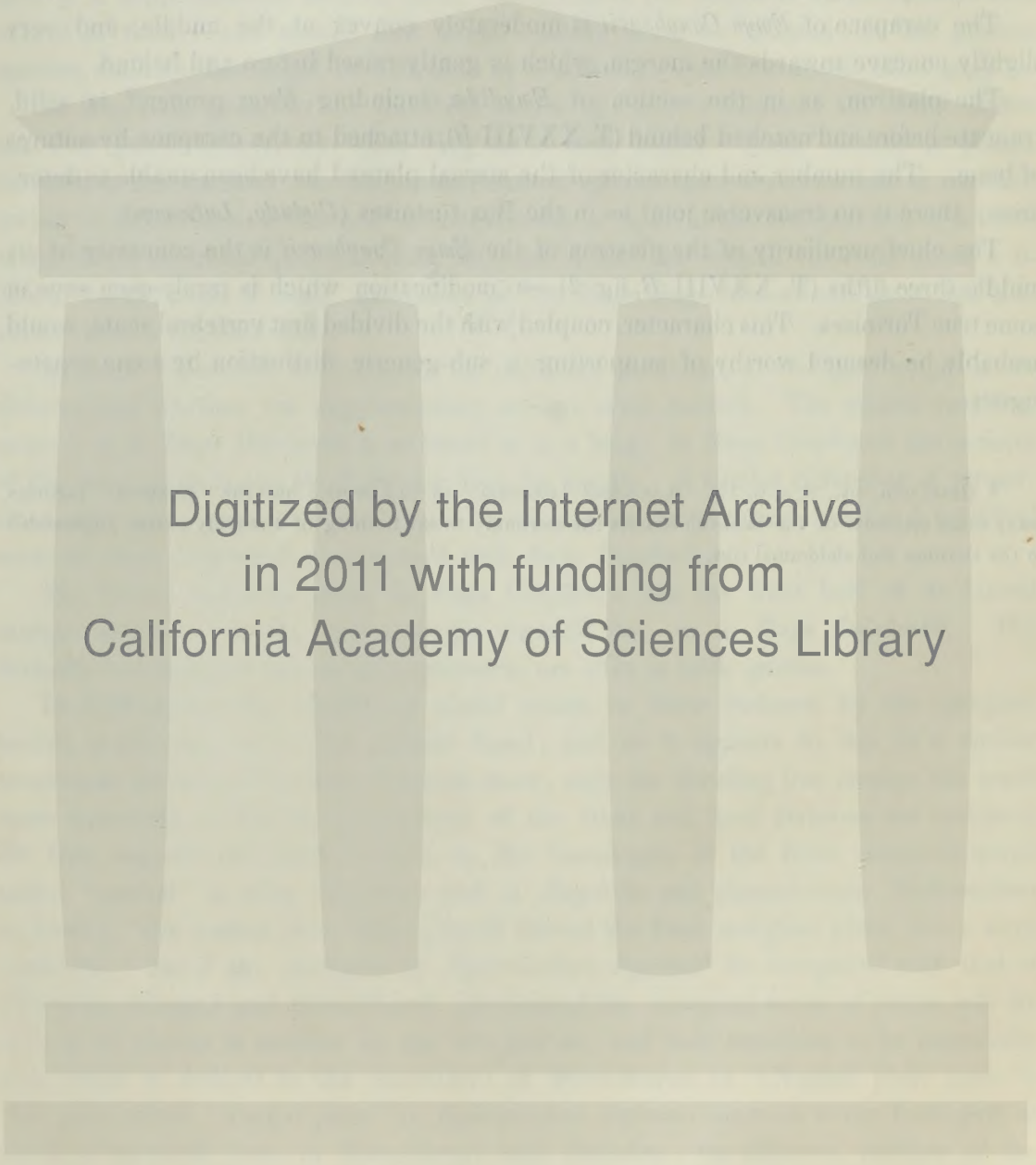
In *Emys nigricans* the nuchal scute is absent, and the number of marginal scutes is as in *Emys Conybearii*.

The carapace of *Emys Conybearii* is moderately convex at the middle, and very slightly concave towards the margin, which is gently raised before and behind.

The plastron, as in the section of *Emydidæ*, including *Emys* proper,* is solid, truncate before and notched behind (T. XXVIII *B*), attached to the carapace by sutures of bone. The number and character of the sternal plates I have been unable to determine: there is no transverse joint as in the Box-tortoises (*Cistudo*, *Lutremys*).

The chief peculiarity of the plastron of the *Emys Conybearii* is the concavity of its middle three fifths (T. XXVIII *B*, fig. 2)—a modification which is rarely seen save in some true Tortoises. This character, coupled with the divided first vertebral scute, would probably be deemed worthy of supporting a sub-generic distinction by some erpetologists.

* Gray, tom. cit., *A*, *a*, p. 15. It is called "sternum" in this work; but the "plastron" includes many other elements of the skeleton besides the sternum; to say nothing of the bony scutes, superadded to the sternum and abdominal ribs.



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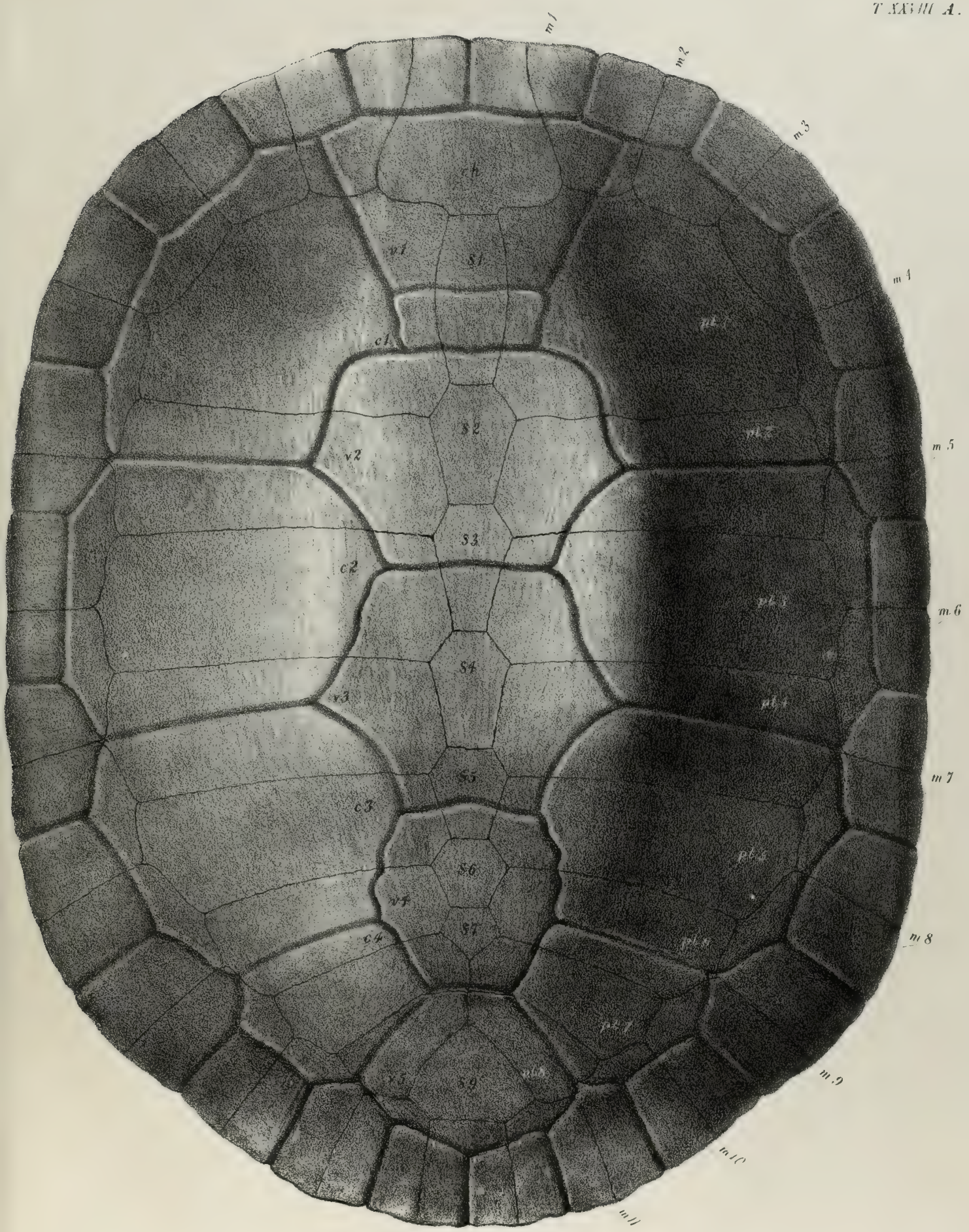
TAB. XXVIII *A.*

Carapace of *Emys Conybearii,* half nat. size.

From the London Clay, Isle of Sheppey, Kent. In the Collection of J. S. Bowerbank, Esq., F.R.S.


m1
m2
m3
m4
m5
m6
m7
m8
m9
m10
m11
ch
v1
s1
c1
pl1
s2
v2
pl2
s3
c2
pl3
s4
v3
pl4
s5
c3
pl5
s6
v4
s7
c4
pl6
pl7
v5
s9
pl8
py

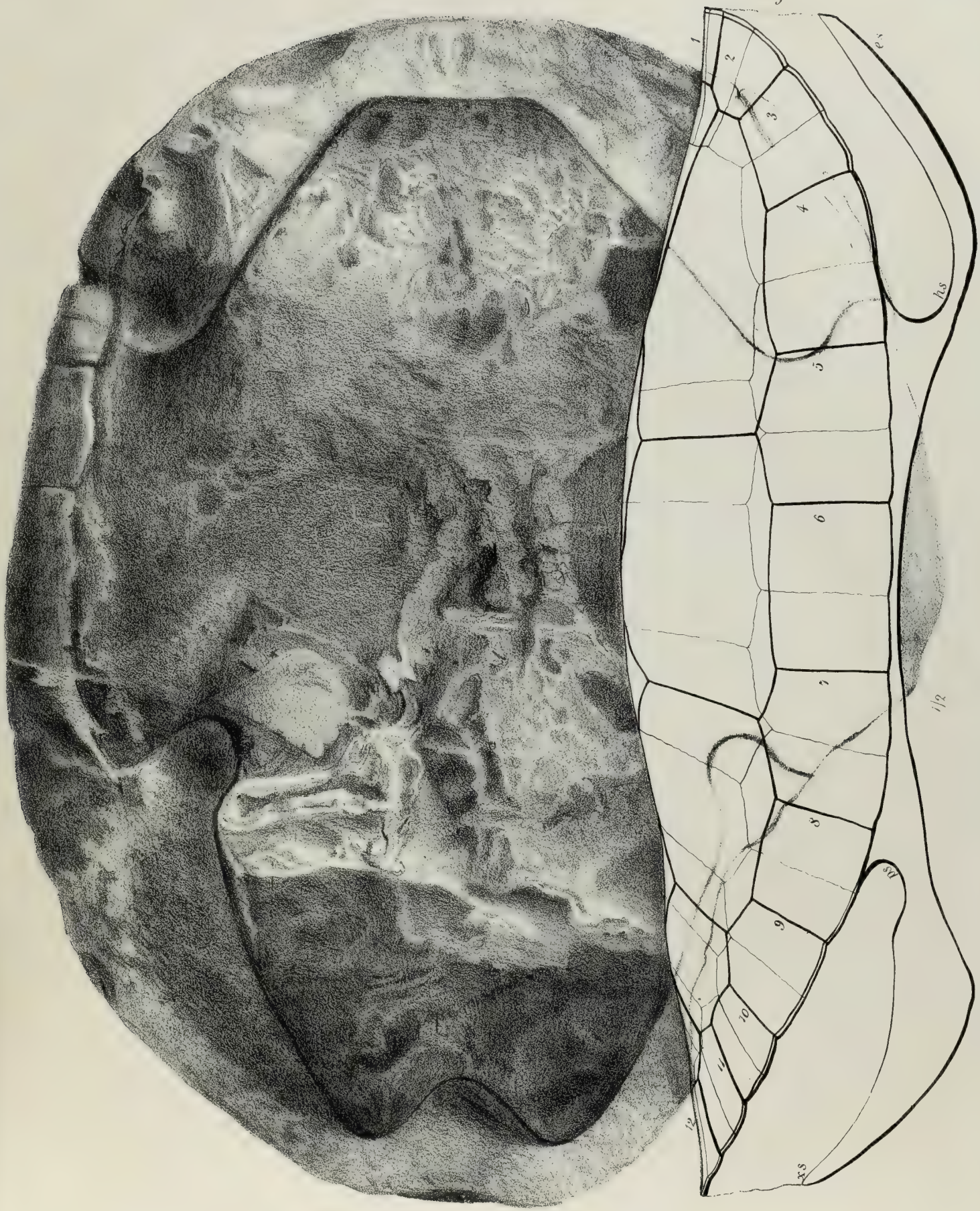
1/2

TAB. XXVIII *B*.

Plastron, and (fig. 2) side view of carapace and plastron in outline, of *Emys Conybearii*, half nat. size.

From the London Clay, Isle of Sheppey, Kent. In the Collection of J. S. Bowerbank, Esq., F.R.S.

Fig 2



THE

# PALÆONTOGRAPHICAL SOCIETY.

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LONDON:

MDCCCLVI.

# A MONOGRAPH

ON THE

# BRITISH FOSSIL

# ECHINODERMATA

FROM

## THE OOLITIC FORMATIONS.

BY

THOMAS WRIGHT, M.D., F.R.S.E.

PART SECOND,

CONTAINING

THE DIADEMADÆ, ECHINIDÆ, SALENIADÆ, AND ECHINOCONIDÆ.

LONDON:
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1856.

J. E. ADLARD, PRINTER, BARTHOLOMEW CLOSE.

The base is flattened, but the mouth opening is unfortunately concealed in the only two specimens I have found.

*Affinities and differences.*—I regarded this urchin, at first sight, as a young form of *H. tetragramma,* but the spaced-out arrangement of the ambulacral tubercles, the inflation of the sides of the test, and the presence of only two rows of tubercles in the inter-ambulacra, show that it is quite distinct from that species. It is so entirely different from *H. perforatus* and *H. Bakeri,* that it cannot be mistaken for either of them.

*Locality and Stratigraphical position.*—I collected this urchin in the Pea Grit at Crickley Hill, with the former. It must be rare, as I only know two examples of the species, which I dedicate to my friend G. R. Waterhouse, Esq., F.Z.S., of the British Museum, well known for his valuable contributions to zoological literature, and by the kindness and urbanity of his manner to all who seek information in that department of the great national collection committed to his care.

HEMIPEDINA BONEI, *Wright.* Pl. X, fig. 5 *a, b, c, d.*

HEMIPEDINA BONEI. Wright, Annals and Magazine of Natural History, 2d series, vol. xvi, p. 98.
— — Woodward, Memoirs of the Geological Survey, Decade v, "notes on Echinopsis."

Test small, pentagonal, depressed; ambulacral areas with two marginal rows of close-set tubercles; inter-ambulacral areas with two entire central rows, and four shorter lateral rows of tubercles, which extend only to the equator; the tubercles of both areas are small and nearly of the same size; base concave; mouth opening of moderate width; peristome nearly equally decagonal.

*Dimensions.*—Height, seven twentieths of an inch; transverse diameter, eight tenths of an inch.

*Description.*—This small pentagonal depressed urchin has the minute tubercles of both areas nearly of the same size (fig. 5 *b, c*); the ambulacral areas are about one third the width of the inter-ambulacral; they have two rows of tubercles, from eighteen to twenty in each row, set on the margin of the areas (fig. 5 *c, d*), with incomplete circlets of small granules surrounding them (fig. 5 *d*), except on their zonal side, where they are absent; the poriferous zones are narrow, straight, and distinctly unigeminal

throughout, and there are three pairs of pores opposite each of the inter-ambulacral plates (fig. 5 *d*).

The inter-ambulacral areas are three times the width of the ambulacral; at the equator there are six rows of tubercles (fig. 5 *d*), nearly of the same size, but only the central row of each column extends from the peristome to the disc, at the base this row is large and very conspicuous (fig. 5 *c*), at the equator the tubercles are a little larger than the lateral rows, and from the equator upwards (fig. 5 *b*), they alone occupy the upper surface of the shell, of the two lateral rows, that on the zonal side is the shortest; there are from sixteen to eighteen tubercles in each of the central rows, and from eight to ten in the lateral rows; the areolas are surrounded by small granules, which form a delicate network on the surface of the plates, (fig. 5 *d*).

The apical disc is absent in all the specimens I have seen, it has an oblong form, and extends further into the single inter-ambulacrum than the other areas (fig. 5 *c*).

The base is slightly concave (fig. 5 *c*), and the tubercles are much larger in this region than on the upper surface (fig. 5 *b*); the mouth opening is large, and the peristome is divided into nearly equal sized lobes.

*Affinities and differences.*—The pentagonal form of this species, with its elongated opening for the apical disc, reminds me of some young *Pygasters*, which occur with it in the same rock; but the size and arrangement of the tubercles, its depressed form, and small discal opening, serve to distinguish it from them; how far a greater number of specimens, especially if the apical disc were preserved, would lead me to modify my opinion as to its generic position, it is impossible to say; I have, therefore, provisionally placed this beautiful little urchin with the *Hemipedinas,* the characters just enumerated being sufficient to show in what it differs from its congeners.

*Locality and Stratigraphical position.*—I have collected this urchin from the Pea grit, Inferior Oolite, of Crickley Hill, associated with the preceding species from the same bed, where it is rare. I dedicate this species to Mr. C. R. Bone, whose beautiful figures of Echinoderms, have given such a lasting value to the plates which accompany this Monograph.

### C. *Species from the Great Oolite and Cornbrash.*

HEMIPEDINA DAVIDSONI, *Wright.* Pl. XII, fig. 6 *a*, *b*, *c*, *d*.

HEMIPEDINA DAVIDSONI. Wright, Annals and Magazine of Natural History, 2d series, vol. xvi, p. 99.

Woodward, Memoirs of the Geological Survey, Decade v, "Notes on Echinopsis."

Test circular, much depressed, ambulacral areas with two marginal rows of tubercles very regularly arranged throughout the area; inter-ambulacral areas wide, with two central rows of primary tubercles, and four lateral rows of secondary tubercles; poriferous zones narrow, and straight; under surface of the test crowded with tubercles, upper surface deficient in tubercles, base concave, mouth opening small, peristome unequally decagonal.

*Dimensions.*—Height, seven twentieths of an inch; transverse diameter, one inch.

*Description.*—I found this urchin about twelve years ago in the sandy beds of the Great Oolite, at Minchinhampton; and although I have searched diligently since in the same locality for other specimens, I have failed. The test is not in very good preservation, but it is still sufficiently so to enable me to describe its characters; the shell is thin, circular, and much depressed; the ambulacral areas are straight and narrow (fig. 6 *a*), being less than one third the width of the inter-ambulacral, on their margins are two rows of tubercles (fig. 6 *d*) in each row, which are very uniform in size throughout, corresponding with a greater uniformity in the width of the area than in some other species; the poriferous zones are narrow; the pores unigeminal throughout (fig. 6 *a*), except at the base, where three additional pairs are crowded in; there are four pairs of pores opposite each inter-ambulacral plate.

The inter-ambulacral areas are three times the width of the ambulacral; each of the elongated pentagonal plates composing the two columns has one central primary tubercle (fig. 6 *d*); these tubercles form an uninterrupted row, which extends from the peristome to the disc; besides the central row, the plates between the peristome and equator have two lateral rows of smaller secondary tubercles (fig. 6 *d*), disposed on each side of the primary one, so that at the equator the inter-ambulacra have six rows of tubercles abreast; above that line, however, the secondary series disappear, and on the upper surface of the test the two primary rows alone exist (fig. 6 *b*); the primary tubercles are very uniform in size throughout, but the secondaries vary much in magnitude (fig. 6 *d*).

The base is flat, the mouth opening is small, being about one third the diameter of the shell, the peristome is decagonal and nearly equal-lobed (fig. 6 *c*).

*Affinities and differences.*—This species resembles *Hemipedina tetragramma*, but the ambulacral tubercles are larger and less numerous; the poriferous zones are narrower, and the pores more strictly unigeminal; the inter-ambulacral areas are wider, and less ornamented with granules and tubercles; the secondary tubercles between the poriferous zones and the primary row (fig. 6 *d*), is absent in *Hemipedina tetragramma*. Pl. X, fig. 3 *d*, the aperture for the apical disc is likewise much larger in *Hemipedina Davidsoni*.

*Locality and Stratigraphical position.*—I collected this urchin from the sandy beds of the Great Oolite, at Minchinhampton Common, where it is extremely rare; the specimen figured is the only one I know. I dedicate this species to my esteemed friend, Thomas Davidson, Esq., author of the 'Monographs on the Fossil Brachiopoda of Great Britain.'

HEMIPEDINA WOODWARDI, *Wright.* Pl. XII, fig. 7 *a, b, c, d.*

HEMIPEDINA WOODWARDI. Wright, Annals and Magazine of Natural History, 2nd series, vol. xvi, p. 99.
— — Woodward, Memoirs of the Geological Survey, Decade v, "Notes on Echinopsis."

Test small, circular, and much depressed; ambulacral areas narrow, with two rows of small tubercles which extend from the base to the equator, and diminish to small granules in the upper part of the areas; inter-ambulacral areas with two rows of primary tubercles, eight in each row, and two rows of secondary tubercles, three to four in each row, which scarcely reach the equator; the miliary zone is wide on the upper surface and filled with numerous close-set granulations; apical disc large, genital plates much developed; mouth opening small, peristome decagonal and nearly equal lobed.

*Dimensions.*—Small specimen, height seven twentieths of an inch; transverse diameter thirteen twentieths of an inch.

*Description.*—This urchin belongs to the type of *Hemipedinas*, which have two rows of primary tubercles, with a wide granulated miliary zone between them on the upper surface of the inter-ambulacral areas; although undescribed, this species has been long known, as there is a fragment of it, collected by Dr. William Smith, from the Cornbrash, which forms part of his collection now in the British Museum.

The ambulacral areas are straight and narrow (fig. 7 *a*), on their lower half, or from the peristome to above the equator (fig. 7 *c*), there are from nine to eleven pairs of tubercles according to the size of the specimen; these tubercles are perforated, and raised on bosses with semicircles of minute granules around them (fig. 7 *d*); from about the equator to the apical disc the tubercles degenerate into granules (fig. 7 *b*), so that the lower half of the area possesses tubercles, whilst the upper half is occupied by granules; the poriferous zones are narrow, and straight; the pores, which are strictly unigeminal, are small (fig. 7 *d*), and there are five pairs of pores opposite each of the inter-ambulacral plates; the septa have slightly raised eminences on the surface.

The inter-ambulacral areas are four times the width of the ambulacral, they have two entire rows of primary tubercles, and two short rows of secondary tubercles; each plate, between the peristome and the equator, has one large tubercle on its zonal side, and one

secondary tubercle on its centro-sutural side (fig. 7 *d*), so that from the base to the equator there are two rows of primary and two rows of secondary tubercles (fig. 7 *a*, *c*), between the equator and the apical disc the secondary tubercles are absent, and the wide miliary zone is occupied by several rows of small close-set granules (fig. 7 *a*, *b*). According to the age of the test, there are from eight to ten primary tubercles and from five to six secondary tubercles in each row.

The apical disc is large (fig. 7 *b*), the heptagonal genital plates are much expanded and perforated near their centre, the ocular plates are proportionately large, and form crescentic arches over the apices of the ambulacra; the surface of both the genital and ocular plates is covered with small granules, the anal opening is central, and the rim of the aperture forms a slight prominence at the vertex.

The mouth opening is small (fig. 7 *c*), the peristome is decagonal, and notched into nearly equal sized lobes; from the development of the tubercles at the base of the test, this region presents a much more tuberculated appearance than the upper surface, where the granules of the ambulacra, and the wide miliary zone of the inter-ambulacra (fig. 7 *b*), form a striking contrast to the tubercles which adorn the lower part of the same divisions of the test at the base (fig. 7 *c* and *d*).

*Affinities and differences.*—In the semi-tuberculous character of the ambulacra this species resembles *Hemipedina perforata*, Pl. X, fig. 2, and *Hemipedina tuberculosa*, Pl. XI, fig. 2, but it is distinguished from both by having secondary tubercles in the inter-ambulacra, which are absent in these species. It resembles *Hemipedina Davidsoni*, Pl. XII, fig. 6, and *Hemipedina tetragramma*, Pl. X, fig. 3, in possessing secondary tubercles in the inter-ambulacra, but the disappearance of the marginal tubercles from the upper parts of the area shows how distinct it is from these congeneric forms.

*Locality and Stratigraphical position.*—This species was collected many years ago by Dr. William Smith, and is probably the specimen from the Cornbrash of Melbury, referred to in his "Strata identified by organized fossils."

My small specimen came from the Cornbrash near Trowbridge, Wilts; the same species has been collected in the Cornbrash near Boulogne-sur-Mer.

I dedicate this species to my excellent friend S. P. Woodward, Esq., of the British Museum, as a mark of respect and gratitude for the trouble and interest he has taken in the success of this work.

HEMIPEDINA MICROGRAMMA, *Wright*, nov. sp. Pl. XII, fig. 4 *a*, *b*, *c*.

Test subpentagonal, depressed; ambulacral areas wide, with four rows of tubercles; poriferous zones narrow and straight; inter-ambulacral areas with eight rows of tubercles

at the equator, diminishing above to six, four, and two rows; tubercles of both areas very small and nearly of the same size; sides rounded, upper and under surfaces much depressed.

*Dimensions.*—Height, eleven twentieths of an inch; transverse diameter, one inch and seven tenths.

*Description.*—The only specimen I know of this species is the one now figured; unfortunately the surface of the test has been rubbed smooth in some places, and distorted and broken in others, so that only an imperfect description of this interesting form can be given.

The ambulacral areas are wide and straight, and retain a very uniform width throughout; at the equator they have four rows of small tubercles (fig. 4 *c*), the two marginal rows are the most regular, as regards size and arrangement, there being about twenty-five tubercles in each row, the two inner rows commence below the equator and extend two thirds of the distance between the equator and the apical disc; they are smaller in size and not so regularly arranged as the outer rows; each row contains from ten to twelve tubercles; between these four rows of tubercles small granules are very regularly interspersed. The poriferous zones are perfectly straight and very narrow, and the pores are small and unigeminal throughout; there are five pairs of pores opposite each of the inter-ambulacral plates. The inter-ambulacral areas are about twice and a half as wide as the ambulacral; each plate at the equator supports four tubercles (fig. 4 *c*), which are so disposed on the consecutive plates of the columns that they form a series of oblique rows (fig. 4 *b*); there are sixteen plates in each column, and in the upper part of the areas the number of tubercles gradually diminishes to three, four, and two on each (fig. 4 *a*). The tubercles of both areas are very small, and nearly of the same size; their bosses are flat, and the narrow areolas are surrounded by a circle of small scorbicular granules, which imparts an ornamental appearance to the test.

The space for the apical disc is large, but as the margin of the aperture is fractured no certain estimate can be made of the probable size of the disc.

The base is concave, and the mouth opening so much concealed by adhering matrix that its form cannot be accurately made out; enough, however, is exposed, to show that the peristome is decagonal and formed of unequal sized lobes.

*Affinities and Differences.*—This urchin belongs to the type of *Hemipedinas* with several rows of equal sized tubercles at the equator; in the number and smallness of its tubercles it is so unlike all its present known congeners that it cannot be mistaken for either of them. In the width of its ambulacra, and in the mode of distribution of the tubercles in oblique rows, it resembles the *Pygasters*.

*Locality and Stratigraphical position.*—It appears to have been collected from the Cornbrash of Northamptonshire; but as the history of the specimen is unknown, this is only conjecture. It forms part of the late Miss Baker's (Northampton) Collection in the British Museum.

## D. *Species from the Coral Rag.*

### Hemipedina Marchamensis. *Wright.* Pl. XI, fig. 1 *a*, *b*.

Hemipedina Marchamensis. Wright, Annals and Magazine of Natural History, 2nd series, vol. xvi, p. 197.
— — Woodward, Memoirs of the Geological Survey, Decade v, "Notes on Echinopsis."

Test large, circular, and depressed; ambulacral areas narrow, with two rows of marginal tubercles, nearly as large as those of the inter-ambulacral; extending regularly, without interruption, from the peristome to the apical disc, and separated by a zig-zag line of small granules, the areas retaining a nearly uniform width throughout; poriferous zones narrow, forming a slightly waved line, every three pairs of pores being set obliquely in the line of the zones; inter-ambulacral areas four times the width of the ambulacral, with eight rows of tubercles at the equator, each tubercular plate supporting four nearly equal sized tubercles abreast; mouth opening large, peristome unequally decagonal.

*Dimensions.*—Transverse diameter, two inches and nine tenths; height, one inch and three tenths.

*Description.*—In the present state of our knowledge, it would be premature to propose subgenera of the remarkable group of urchins now under consideration, but it is evident that we have at least two sections of the genus *Hemipedina*, among its forms now known. 1st, those with two rows of primary tubercles, a wide miliary zone, and sometimes rows of secondary tubercles in the inter-ambulacral areas. 2d, those with four, six, eight, or even ten rows of nearly equal sized tubercles abreast, in the same region of the test; *Hemipedina Woodwardi*, and *Hemipedina tuberculosa*, are types of the first section; *Hemipedina Marchamensis*, and *Hemipedina Bouchardii*, are types of the second. At first sight, it seems difficult to believe that the two urchins, figured in Pl. XI, fig. 1 and 2, belong to the same genus, but a careful analysis of their structure does not afford any permanent characters for generic separation.

A parallel case is afforded by the genus *Pseudodiadema*, where one section has two

rows of primary tubercles in the inter-ambulacra, and another has four rows of primary tubercles in the same region of the test.

The section of which *Hemipedina Marchamensis* is the type, appears to belong to the middle and upper division of the Oolites, as the only species exhibiting these hexagrammous and octogrammous characters, are found in the Calcareous Grit, Coral Rag, and Kimmeridge Clay.

The test of *Hemipedina Marchamensis* is large, nearly perfectly circular at the equator, and depressed on the upper surface; it appears to have had a hemispherical form, but unfortunately the upper portion of the body is fractured, and the outline is traced with difficulty, in consequence of adhering matrix. The ambulacral areas are narrow (fig. 1 *a*), with two marginal rows of tubercles, closely placed together, along the sutural line, two rows of granules separate the tubercles (fig. 1 *b*), and transverse branches from these bound the areolas; the poriferous zones, which closely embrace the bosses, are slightly undulated (fig. 1 *b*), from the pores being grouped in threes, the septa are thin and elevated on the surface, and there are five pairs of pores opposite each large plate (fig. 1 *b*).

The inter-ambulacral areas are four times as wide as the ambulacral (fig. 1 *a*); they are crowded throughout with numerous rows of nearly equal sized tubercles, which, added to the regular rows in the ambulacra, impart a most remarkable tuberculous character to this urchin; the inter-ambulacral plates near the equator (fig. 1 *b*), have three large tubercles placed on the same line, and one or two smaller tubercles on their zonal sides, so that at the equator there are eight rows of tubercles; the bosses are large and prominent, and the tubercles are small and deeply perforated; estimating the number of plates in each column at about twenty, each area would contain $20 \times 2 = 40 \times 4 = 160$ tubercles, which multiplied by five areas, gives 800 tubercles in the inter-ambulacral areas of this species; the areolas are narrow and superficial, and surrounded by a complete circle of small granules (fig. 1 *b*), the tubercles of the inter-ambulacra are a little larger than those of the ambulacra.

The base of the test, which is well preserved, is slightly convex at the sides, and depressed at the centre (fig. 1 *a*); the regular distribution of the numerous tubercles gives this region of the shell a highly ornamented appearance, which is admirably represented in (fig. 1 *a*), the mouth opening is not quite one third the diameter of the body, the peristome is unequally decagonal, the ambulacral lobes being the largest; the jaws are large and powerful, and project from the mouth with the teeth "in situ."

The upper surface of the test is unfortunately absent, the specimen having been detached from the rock, without due care having been taken to preserve the part to which it adhered, and which evidently contained the other portion of the shell.

*Affinities and differences.*—This splendid urchin resembles *Hemipedina Corallina*, from the Coral Rag, in the number of the tubercles developed on the inter-ambulacral plates,

but is distinguished from it by the greater size they attain in *Hemipedina Marchamensis*. It resembles, likewise, *Hemipedina Bouchardii*, from the Kimmeridge Clay of Boulogne-sur-Mer, but as that species has ten small tubercles on the inter-ambulacral areas, our species, which has only eight, is distinct from it, whilst they both belong to that section of the genus with numerous tubercles ranged on the same line on the plates.

*Locality and Stratigraphical position.*—This species was collected from the lower Calcareous Grit of Marcham, Berks, and belongs to the collection of the Hon. R. Marsham, who kindly communicated it for publication.

HEMIPEDINA CORALLINA, *Wright*, nov. sp. Pl. XII, fig. 1 *a*, *b*, *c*, *d*.

Test large, form unknown; ambulacral areas narrow, with two marginal rows of tubercles; inter-ambulacral areas wide, equatorial plates with five or six tubercles on each; spines long and slender, stem nearly a uniform diameter and covered with fine, close-set longitudinal lines, tubercles of both areas small and nearly of the same size.

*Description.*—The diagnosis of this species is most imperfect, as I only know the fragments of the test I have figured, which doubtless formed portions of large urchins; fig. 1 *a* was collected by Mr. Bean, from the Coralline Oolite of Malton; the ambulacral areas of this specimen have two marginal rows of small tubercles placed rather wide apart.

The inter-ambulacral areas are three times the width of the ambulacral. On the large equatorial plates (fig. 1 *b*, *c*), there are four rows of primary tubercles abreast, with two smaller secondary tubercles at the zonal side of the plates (fig. 1 *c*), which would give eight rows of tubercles in the inter-ambulacral areas; the areolas are wide and smooth, and surrounded by circles of small granules (fig. 1 *b*, *c*).

The mouth opening is large, and the jaws, which are preserved in situ, are powerful, and armed with strong teeth (fig. 1 *a*).

The spines are long and slender; the head is short and stout (fig. 1 *d*); the stem tapers very little; the milled ring is prominent, and on it and on the surface of the stem are numerous fine close-set longitudinal lines.

*Affinities and differences.*—In the number of its tubercles in the inter-ambulacra, this species resembles *Hemipedina Marchamensis* (Pl. XI, fig. 1), but they are much smaller in size, have much smaller bosses, and wider and smoother areolas than in that species; unfortunately, the fragments admit of no further comparison.

*Locality and Stratigraphical position.*—The fragment (fig. 1 *a*) was the only portion

Mr. Bean ever saw after collecting many years from the Coralline Oolite of Malton, Yorkshire, and fragment (fig. 1 *b*), is the only portion showing the external surface of the plates I have obtained from the Coral Rag of Calne, Wilts; from this locality, however, I have seen the interior of a large *Hemipedina* which was upwards of three inches in diameter, having the jaws "in situ," but as the external surface of all the plates was concealed, the species was indeterminable, it most probably however belonged to this species, as the figure of the plates was the same as those in (fig. 1 *b*, *c*).

HEMIPEDINA TUBERCULOSA, *Wright*. Pl. XI, fig. 2 *a*, *b*, *c*, *d*, *e*, *f*.

| | | |
|---|---|---|
| HEMIPEDINA TUBERCULOSA. | | Wright, Annals and Magazine of Natural History, 2nd series, vol. xvi, p. 99. |
| — | — | Woodward, Memoirs of the Geological Survey, Decade v, "Notes on Echinopsis." |
| — | — | Desor, Synopsis des Échinides Fossiles, p. 60. |

Test hemispherical, depressed; ambulacral areas narrow, with two rows of semi-tubercles at the base, which extend as high as the equator; upper part of the areas with two rows of very small marginal granules; interambulacral areas with two rows of primary tubercles set on prominent bosses, the areolas surrounded by circles of coarse scrobicular granules; between the peristome and the equator there are two rows of small secondary tubercles on the zonal side of the plates, and several at the base of the rows; the miliary zone is wide, and covered with coarse granules, the sutural lines are naked above; mouth opening large, the peristome very unequally lobed, the ambulacral being double the size of the inter-ambulacral lobes; anal opening large; spines moderately stout and covered with longitudinal lines.

*Dimensions.*—Height, seven tenths of an inch; transverse diameter, one inch and one fifth of an inch.

*Description.*—This new and beautiful urchin was only discovered a few months ago in the Coral Rag of Wiltshire. The original type specimen, belonging to the British Museum, has so much of the matrix adhering to its upper surface that its true form is concealed; the discovery, however, of the fine specimen I have figured, now enables me to give very full details of its structure, including even the spines.

The ambulacral areas are narrow; their basal half is enlarged, and filled with two rows of semi-tubercles gradually increasing in size from the peristome to the uppermost tubercle (fig. 2 *b*, *c*, *d*), like the semi-tubercles of the same region in the genus *Hemicidaris;* there are eight tubercles in each row (fig. 2 *c*) which alternate with only a solitary granule at

the angles between them (fig. 2 *d*); beyond the semi-tubercles the area becomes contracted, and the upper half of the space is filled with two marginal rows of small granules from sixteen to eighteen in each row (fig. 2 *c*, *d*), the very great difference between the structure of the inferior and superior parts of the ambulacral areas forms a remarkable feature in the diagnosis of this urchin.

The poriferous zones are slightly undulated (fig. 2 *c*, *d*); from the apical disc to the fourth pair of semi-tubercles the pores are unigeminal; but from this point to the peristome the area contracts and the zones expand to fill up the increase of space at the base, in this region (fig. 2 *b*), the pores fall into triple oblique pairs; between the pores, forming a pair, the septa form an elevated moniliform line (fig. 2 *d*); and there are five pairs of pores opposite each inter-ambulacral plate.

The inter-ambulacral areas are twice and a half the width of the ambulacral (fig. 2 *a*, *c*); they are filled with two rows of primary tubercles, eight tubercles in each row, which gradually increase in size from the peristome to the equator (fig. 2 *c*), and then as gradually diminish as they approach the apical disc (fig. 2 *a*); the mammillary bosses of these tubercles, especially those about the centre of the rows, are large and prominent (fig. 2 *d*); their summits are broad and smooth (fig. 2 *c*, *e*), and the areolas are not wide (fig. 2 *e*), there are two rows of secondary tubercles on the zonal side of the primaries (fig. 2 *b*), which extend from the peristome to near the equator, and a few others, about six, at the basal portion of the centro-sutural region (fig. 2 *b*, *d*), the miliary zone is broad (fig. 2 *a*), and filled with from four to six rows of coarse, unequal-sized granules, some of them even assuming the form of minute tubercles (fig. 2 *d*); the areolas are surrounded by these granules, which form complete scrobicular circles in the three uppermost tubercles (fig. 2 *a*), and incomplete circles in the lower ones (fig. 2 *d*), the sutural lines in the centro-sutural region are very distinctly marked.

The mouth opening is large, being one half the diameter of the test at the equator, the peristome is very unequally lobed, the ambulacral lobes being double the size of the inter-ambulacral.

The apical disc is absent, but as the opening is very large it indicates a great development of the plates composing it, which, in the only four specimens I at present know, are entirely absent.

Two of the spines are fortunately preserved in our specimen (fig. 2 *a*, *f*); they are cylindrical, with a prominent milled ring, and a small head (fig. 2 *f*), the surface of the stem is covered with longitudinal lines; the stem is unfortunately broken, so that its length is not known.

*Affinities and differences.*—This urchin might easily be mistaken for a *Hemicidaris*, like that genus it possesses two rows of semi-tubercles at the base of the ambulacra, and two rows of primary tubercles in the inter-ambulacra; but the absence of crenulations

from the summits of the bosses, the presence of secondary tubercles in the inter-ambulacra, and the great size of the discal opening, are characters which serve to distinguish it from *Hemicidaris*.

It forms the best type of that section of the genus, which has two rows of tubercles in the inter-ambulacra, with a wide miliary zone; the contrast between the two sections of the group is strikingly exemplified by comparing figures 1 and 2 of Plate XI, where *Hemipedina Marchamensis*, and *Hemipedina tuberculosa* are drawn side by side.

In the structure of the ambulacral areas, with tubercles below, and granules above, and with two rows of tubercles in the inter-ambulacra, this species resembles *Hemipedina Woodwardi*, but the tubercles in *Hemipedina tuberculosa* are much larger, the granules are more developed, and it is a higher and more inflated form than the Cornbrash species.

Our urchin very much resembles the mould in plaster named *Hemicidaris depressa*, Agassiz, "X 55, R 44. Cat. Syst. p. 8. Espèce plate, subconique, à ambulacres non flexueux" from the Forest Marble, of Ranville,* but it is impossible to make a critical comparison of that form with *Hemipedina tuberculosa*, without a typical specimen; at present I know of no other form for which this beautiful urchin could be mistaken.

*Locality and Stratigraphical position.*—This species has been found only in the Coral Rag of Wiltshire, by Mr. William Buy; the fine specimen I have figured, was discovered by him near Lyneham; it is a very rare form, as that able and accurate collector has only found three or four specimens of the species.

### E. *Species from the Kimmeridge Clay.*

HEMIPEDINA MORRISII, Pl. XII, fig. 2 *a, b, c, d, e.*

HEMIPEDINA MORRISII. Wright, Annals and Magazine of Natural History, 2d series, vol. xvi, p. 198.
— — Woodward, Memoirs of the Geological Survey, Decade v, "Notes on Echinopsis."

Form and size unknown; test small; ambulacral areas with two rows of prominent marginal tubercles; poriferous zones slightly waved; inter-ambulacral areas with four rows of prominent tubercles at the equator, nearly on the same line, surrounded by incomplete circlets of granules.

*Description.*—The only portion of this urchin I have seen, is that now figured;

* Annales des Sciences Naturelles, 3ème série, tome vi, p. 338, Agassiz and Desor. Catalogue raisonné des Échinides.

the ambulacral areas are moderately wide, they have two rows of regular, prominent, marginal tubercles, which gradually diminish in size from the base to the summit of the areas, and are separated by a zig-zag line of small granules occupying the line of the suture (fig. 2 *b*); the poriferous zones are slightly waved, the pores are separated by thick septa, the external surface of which form slight eminences, and there are five pairs of pores opposite each large plate.

The inter-ambulacral areas are three times the width of the ambulacral, each plate supports two primary equal-sized tubercles (fig. 2 *b*), which have prominent bosses with well-defined areolas, surrounded by incomplete circlets of small granules (fig. 2 *b*).

The long, round, slender spines referred to this species (fig. 2 *c*) have their surface sculptured with fine longitudinal lines; the articulation is small, with a smooth rim; the head is short and stout, with a thin, finely milled, prominent ring; the stem is much smaller in diameter than the head.

*Affinities and differences.*—The fragment (fig. 2 *a*) is all that I have seen of the test of this species; it belongs to the section with several rows of tubercles in the inter-ambulacra, but the specimen is too imperfect for comparison with other forms.

*Locality and Stratigraphical position.*—This species was collected by Z. Hunt, Esq., from the Kimmeridge Clay, at Hartwell, Bucks, and was kindly communicated by Professor Morris, to whose collection it belongs.

HEMIPEDINA CUNNINGTONI, *Wright*. Pl. XII, fig. 3 *a*, *b*.

HEMIPEDINA CUNNINGTONI. Wright, Annals and Magazine of Natural History, 2d series, vol. xvi, p. 198.
— — Woodward, Memoirs of the Geological Survey, Decade v, "Notes on Echinopsis."

Form unknown; ambulacral areas with two marginal rows of very small tubercles; poriferous zones straight, pores obliquely disposed; inter-ambulacral areas with two rows of tubercles on the zonal sides of the plates, miliary zone wide, filled with from eight to ten rows of small granules; bosses large and prominent; areolas surrounded by complete circles of granules.

*Dimensions.*—Transverse diameter, upwards of one inch; height unknown.

*Description.*—The fragment figured 3 *a*, *b*, is all that is known of this urchin, which shows that it belongs to that group of the *Hemipedinas* having two rows of tubercles on the poriferous side of the plates, and a wide miliary zone between them. It is much to be

desired that a more diligent search should be made for Echinoderms, in Kimmeridge Clay districts, as the little at present known of this class consists only of fragments of tests and detached spines.

The ambulacral areas are narrow, with two marginal rows of small tubercles, rather irregular in the mode of their arrangement (fig. 3 *b*); the poriferous zones are straight, the pores are placed obliquely, and there are four pair of pores opposite each large plate.

The inter-ambulacral areas are three times the width of the ambulacral; they have only one row of tubercles on the zonal sides of the plates (fig. 3 *b*), which leaves a wide space between the areolas and the central suture; this is filled with four or five rows of small granules, which, with those on the adjoining plate, form a miliary zone with from eight to ten rows of granules; the bosses are large and prominent, and the tubercles are of proportionate magnitude, the areolas are complete, and surrounded by circles of granules of the same size as those which fill the zone.

*Affinities and differences.*—The fragment (fig. 3 *a*) formed part of a species belonging to the first section of the genus, with two rows of tubercles, and a wide miliary zone in the inter-ambulacra, but, like the preceeding species, it is too imperfect for comparison.

*Locality and Stratigraphical position.* — This fragment was collected from the Kimmeridge Clay, near Aylesbury, by Z. Hunt, Esq. and was kindly communicated by Professor Morris.

# NOTES.

## Of Foreign Jurassic species of the genus HEMIPEDINA nearly allied to British forms, but which have not yet been found in the English Oolites.

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Hemipedina seriale, *Leymerie.* Mém. de la Société Géologique de France, 1839, tome ii, Pl. 24, fig. 1.
*Wright.* Monogr. Brit. Ool. Echinodermata. Pl. IX, fig. 3 *a*, *b*.

Test hemispherical, subglobose above, flat below; ambulacral areas, with two rows of tubercles, nearly as large as those of the inter-ambulacra; inter-ambulacral areas, with six rows of tubercles abreast at the equator, diminishing to four, and two rows above; a few secondary tubercles are unequally distributed amongst them; mouth opening small; peristome slightly decagonal.

*Formation.*—Lower Lias, France.

*Collection.*—M. Michelin, Paris.

Hemipedina Sæmanni, *Wright.* Nov. sp.

Test small, hemispherical; ambulacral areas with two rows of tubercles; inter-ambulacral areas with one row of primary, and two rows of secondary tubercles, the primary alternating with the secondary tubercles, but not disposed on the same line, as in most other species; tubercles of both areas nearly the same size.

*Formation.*—Coral Rag, Commercey, Meuse.

*Collection.*—My cabinet, kindly sent by M. Sæmann, of Paris.

HEMIPEDINA NATTHEIMENSE, *Quenstedt.*

ECHINOPSIS NATTHEIMENSIS. Quenstedt, Handbuch der Petrefactenkunde, pl. 49, fig. 37.

Test small, sub-pentagonal, depressed; ambulacra straight, one half the width of row inter-ambulacra, with two rows of tubercles, nine to ten in each; a row of granules extends along the tract of the suture, and transverse branches pass in lateral directions from the main line; poriferous zones narrow, and strictly unigeminal; inter-ambulacra twice as wide as the ambulacra, with two rows of primary tubercles, nine in each row, placed near the centre of the plates; the bosses surrounded by distinct areolas, complete circles of small granules encircle them; near the base, some of the granules attain the size of secondary tubercles, with perforated summits; the tubercles of both areas small and nearly of the same size, those of the inter-ambulacra a little larger than those of the ambulacra; apical disc small; the ocular plates extend beyond the line of the genitals, and are perforated near their centre; vent round, surface of the disc covered with small granulations; mouth opening large and decagonal, lobes unequal.

*Dimensions.*—Transverse diameter, eleven twentieths of an inch.

*Formation.*—White Jura, ε. Nattheim.

*Collections.*—Professor Quenstedt, Tübingen.
British Museum.

HEMIPEDINA BOUCHARDII, *Wright,* nov. sp. Mr. Davidson's MS., Plate III bis., figs. 1, 2, 3.

Test large, depressed; ambulacral areas with two rows of regular marginal tubercles, extending without interruption from the peristome to the apical disc; and separated by a median row of granules, with transverse branches; poriferous zones narrow, straight, and strictly unigeminal; inter-ambulacral areas three times the width of the ambulacral, with ten rows of tubercles at the equator, each inter-ambulacral plate in this region having five tubercles arranged on the same line; areolas narrow, and surrounded by circles of granules; tubercles of both areas small and nearly of the same size; spines long, slender; stem covered with well-marked longitudinal lines.

*Dimensions.*—Transverse diameter, two inches and one quarter; height unknown, a the specimen is crushed.

*Formation.*—Kimmeridge Clay, collected by M. Bouchard Chantereaux, from a cliff near Boulogne-sur-Mer. Very rare.

*Collection.*—M. Bouchard-Chantereaux, at Boulogne-sur-Mer.

*Genus*—PEDINA, *Agassiz*, 1840.

The urchins grouped in this genus are sometimes large, but in general they are of moderate size; their test is much inflated at the sides, and nearly equally depressed on the upper and under surfaces. The shell is extremely thin, and the plates have numerous small tubercles developed on their surface.

The ambulacral areas are narrow, from one third to one fourth the width of the inter-ambulacral; they have two rows of marginal tubercles, often as large as those of the other areas.

The inter-ambulacral areas are wide, with two rows of primary, and two or four rows of secondary tubercles, which extend only from the peristome to the circumference. The tubercles are perforated, the bosses have smooth uncrenulated summits, and the areolas are narrow and superficial.

The poriferous zones are wider than in the other DIADEMADÆ, and the pores are arranged in oblique ranks, with three pairs in each file. In this respect the *Pedinas* resemble the ECHINIDÆ, and form a connecting link between these two natural families.

The mouth opening is small, in general from one third to one fourth the diameter of the test; the peristome is divided by narrow superficial notches into ten nearly equal-sized lobes.

The apical disc is small; the genital plates are nearly equal, but the right antero-lateral, with the madreporiform body, is a little larger than the others; the ocular plates are small, and both genitals and oculars are perforated near their outer third.

The spines, unfortunately, are unknown.

The *Pedinas* were first described by Professor Agassiz as having perforated tubercles, with crenulated bosses. "Enfin un dernier caractère de ce genre consiste dans la petitesse de ses tubercles, lesquels cependant sont perforés et mamelonnés comme ceux des Diadèmes."*

In their 'Catalogue raisonné des Échinides,'† MM. Agassiz and Desor defined this genus—"Oursins comprimés, à test mince, à bouche petite, peu entaillée. Trois paires de pores obliques. Tubercles perforés et crénulés comme chez les Diadèmes. Toutes les espèces sont fossiles; des terrains Oolitiques et Crétacés."

The same definition was adopted by M. Cotteau;‡ and as the specimen I first described was not well preserved, I repeated§ the statement on the authority of these writers.

The discovery, however, of a number of good specimens of *Pedina rotata* enabled me

* 'Échinodermes Fossiles de la Suisse,' 2de partie, p. 33.

† 'Annales des Sciences Naturelles,' 3me serie, tome vi (1846), p. 370.

‡ 'Études des Échinides Fossiles,' p. 191.

§ 'Annals and Magazine of Natural History,' 2d series, vol. viii, p. 272.

to prove that the bosses are smooth, and without any trace of crenulation, in this genus ;* the accuracy of this observation has been confirmed by M. Cotteau,† who has added the following note to his description of *Pedina aspera* : " M. Wright est le premier qui a constaté contrairement à l'opinion de M. Agassiz, que les tubercles des Pédines sont certainement depourvus de crénelures. Sur tous les échantillons de Pédine, que nous avons examinés depuis, nous avons été à même de reconnaître l'exactitude de cette observation."

When I first pointed out the true structure of the bosses in the *Pedinas* to my late colleague, Professor Edward Forbes, he considered the fact of so much importance, that he proposed to suppress the genus *Pedina*, and merge its species into *Echinopsis*, as one of the characters given of *Echinopsis* was that " the tubercles were perforated but not crenulated." For this reason, in the class Echinodermata in Morris's ' Catalogue of British Fossils,' from the pen of Professor Forbes, and likewise in lettering Plate 3, Decade V, of the ' Memoirs of the Geological Survey,' this view was carried out.

The genus *Pedina* was well described and figured by Agassiz in his ' Échinodermes Fossiles de la Suisse,' and its limits accurately indicated, before *Echinopsis* was proposed. Assuming, therefore, that the diagnosis of both genera was equally well defined, which is not the case, still *Pedina* has the priority.

In the absence of good type specimens, it is impossible to make a correct comparison between *Echinopsis* and *Pedina* from the definitions in the books; and if M. Desor, who has lately carefully examined the types of *Echinopsis*, declares the genus to be unsatisfactory, this is another reason why we should retain *Pedina*. In his note on this genus, M. Desor‡ says : " Mais même tel qu'il est ici défini, le genre *Echinopsis* est encore moins précis qu'on ne pourrait le désirer, car il renferme des espèces à pores simples et d'autres à pores dédoublés. Mais comme ces deux types sont si voisins sous tous les autres rapports, particulièrement par leur forme renflée, la petitesse de leur péristome et la structure de leur plaques, je n'ai pas cru devoir les séparer génériquement. Je me suis borné à en faire deux groupes."

The genera *Pedina* and *Echinopsis* are the only ones in which we find perforated tubercles combined with trigeminal pores; but in *Echinopsis* the ambulacral areas are nearly as wide as the inter-ambulacral, which is not the case in *Pedina*.

The *Pedinas* have perforated tubercles, with smooth bosses, combined with trigeminal pores, by which they are distinguished from *Pseudodiadema*. They closely resemble *Hemipedina*, from which they are chiefly distinguished by the smallness of their tubercles, and the trigeminal arrangement of their pores, those in *Hemipedina* being unigeminal; the apical disc is likewise much larger in *Hemipedina*.

The perforation of the tubercles distinguishes *Pedina* from the true Echinidæ, which it otherwise resembles in having a thin test, with trigeminal pores.

* ' Annals and Magazine of Natural History,' 2d series, vol. xiii, p. 173.

† ' Études sur les Échinides Fossiles,' pp. 313, 314.

‡ ' Synopsis Échinides Fossiles,' p. 99.

The *Pedinas* are all extinct, and appear to be limited to the Oolitic rocks. One species is catalogued with doubt as coming from the Cretaceous formation.

PEDINA ROTATA, *Wright* (non Agassiz). Pl. XIII, fig. 1 *a*, *b*, *c*, *d*, *e*.

| | |
|---|---|
| ECHINUS LINEATUS. | Murchison, Geology of Cheltenham, 2d edit., p. 73 (1845). |
| PEDINA ROTATA. | M'Coy, Annals and Magazine of Natural History, 2d series, vol. ii, p. 20 (1848). |
| — — | Wright, Annals and Magazine of Natural History, 2d series, vol. viii, p. 273 (1851). |
| ECHINOPSIS ROTATA. | Forbes, in Morris's Catalogue of British Fossils, 2d edit., p. 78 (1854). |
| — — | Salter, Memoirs of the Geological Survey, Decade V, pl. 3 (1856). |
| PEDINA ROTATA. | Cotteau, Études sur les Échinides Fossiles, p. 315 (1856). |

Test circular, or sub-pentagonal, with tumid sides, more or less depressed; ambulacral areas narrow, furnished with two marginal rows of small, numerous (from twenty-five to thirty in each row,) close-set, equal-sized tubercles, arranged with great regularity throughout; and two inner rows of minute tubercles, which disappear above and below; inter-ambulacral areas wide, with two rows of primary, which extend without interruption from the mouth to the disc, and four rows of secondary tubercles on their outer side, which disappear at the equator; mouth opening small, peristome decagonal, with deep notches and unequal-sized lobes, apical disc of moderate size, genital plates nearly equal, poriferous zones wide, trigeminal ranks oblique, with two granules between each rank.

*Dimensions.*—Height, seven tenths of an inch; transverse diameter, one inch and four tenths.

*Description.*—There is much difficulty in distinguishing by good characters the different species of *Pedina* figured by M. Agassiz in his 'Échinodermes Fossiles de la Suisse,' arising in a great measure from the thinness of the test, the delicacy of its sculpture, and the great similarity which prevails among the different species of this group; the absence of good details of structure in the plates, showing the specific characters of each form, and of an accurate diagnosis in their description, tends to increase the difficulty; any attempt, therefore, to clear up the synonymy of these species is hopeless, without an attentive examination of the types themselves; fortunately, this has been done by a most competent and learned observer, M. Cotteau, whose analysis of the species will be given when treating of the affinities of the urchin now under consideration.

In my Memoir on the Cidaridæ of the Oolites, I erroneously identified this species with *Pedina rotata*, Agass., which is now considered by MM. Agassiz and Desor to be a

variety of *Pedina sublevis;* that name having thus become obsolete, so far as it relates to the Swiss urchin, and our species having been beautifully figured, in the 'Memoirs of the Geological Survey,' under the specific name I first gave it, I have retained it in this work.

The test of this urchin is in general circular, but in some specimens it has a sub-pentagonal form (fig. 1 *b*). Its sides are always more or less tumid, and it is nearly equally depressed on the upper and under surfaces (fig. 1 *e*).

The narrow ambulacral areas are furnished with two rows of small, numerous, equal-sized tubercles, from twenty-five to thirty in each row, which are closely set together on the margins of the area, and arranged with great regularity throughout; in the middle third there are two rows of minute tubercles within the marginal rows, which disappear above and below; a double line of small granules descends in a zigzag form between the tubercles, and sends small lateral branches, to encircle the marginal rows (fig. 1 *a*, *b*, *e*).

The inter-ambulacral areas are four times as wide as the ambulacral (fig. 1 *c*); in the specimen figured there are fifteen plates in each column; each plate supports one primary tubercle, situated near the zonal border of the plate (fig. 1 *e*), and between the peristome and the circumference, two secondary tubercles, on the sutural side of the primaries (fig. 1 *e*); on the upper surface the secondary tubercles gradually disappear, so that the under surface of the test (fig. 1 *a*) is much more tuberculous than its upper surface (fig. 1 *b*); the areolas are very narrow, but not at all excavated, and around them circles of small granules are regularly disposed; the primary tubercles form ten conspicuous rows, which are nearly equidistant from each other, whilst the secondary tubercles are not so regular in their arrangement.

The poriferous zones are wide, in which the holes are closely arranged in triple oblique pairs; the obliquity, however, is greater on the upper than on the under surface, where the holes are so disposed, that the undermost pair of each trigeminal rank forms an oblique line with the uppermost pair of the rank immediately below it, leaving the middle pair by themselves, thus— ⁘ Each pair is surrounded by a slight oval rim, which is only seen, however, on the best-preserved specimens; there are three oblique pairs of holes opposite each large plate (fig. 1 *c*); and between each trigeminal rank there are two small tubercles (fig. 1 *b*).

The base is flat, the mouth opening small, being about two sevenths the diameter of the test; the peristome is decagonal (fig. 1 *a*), and divided by deep notches into ten nearly equal-sized lobes, those corresponding to the ambulacra are the largest.

The apical disc is moderately large, being two sevenths the diameter of the test (fig. 1 *b*); it is often well preserved, as in fig. 1 *b*; the genital plates are nearly all of the same size (fig. 1 *d*); the right antero-lateral, supporting the fine spongy madreporiform body, is a little larger than the others (fig. 1 *d*); they have all a heptagonal shape, and

their apices form angles re-entering into the inter-ambulacral areas (fig. 1 *b*); the ocular plates are small pentagonal pieces, firmly wedged between the genitals; the eye-holes are very minute, and the surface of the discal elements is covered with numerous small granules; the oviductal and eye-holes are perforated about the junction of the outer with the middle third of the plates. The anal aperture is central and circular (fig. 1 *d*), and in diameter is about the length of one of the genital plates.

*Affinities and differences.*— This species very much resembles *Pedina Gervillii*, Desmoulins, in fact, it requires a close and critical comparison of good specimens to discover the differences between them; *Pedina rotata* has more tumid sides, the ambulacral areas possess a greater number of small, equal-sized tubercles, more closely set together, and arranged with greater regularity than in *Pedina Gervillii;* the poriferous zones are likewise wider, and the pores lie more oblique, with two granules between each rank; the primary tubercles are larger and more prominent; and there is, consequently, a greater disproportion between the tubercles of the ambulacral and those of the inter-ambulacral areas than in *Pedina Gervillii*.

It differs from *Pedina sublevis* in having larger tubercles in the inter-ambulacra, and in the number, approximation, and regularity of the arrangement of the ambulacral tubercles.

M. Cotteau* has examined the types of M. Agassiz' species contained in the magnificent collection of M. Michelin, and has given the following analysis of the affinities and differences which exist between the four species he describes, and which I have translated for this section.

"1st. The *Pedina sublevis*, Agassiz, which is characterised by its great height, its pores disposed by very oblique triple pairs, its primary tubercles slightly developed, spaced out, and confounded, so to speak, especially at the base, with the secondary tubercles which accompany them. We consider the *Pedina ornata*, Ag., as a variety of this species.

"2d. The *Pedina Gervillii*, Desmoulins; remarkable by its depressed form, its principal ambulacral and inter-ambulacral tubercles few in number and spaced out, its secondary tubercles very small, its pores largely open, ranged in triple oblique pairs, with little obliquity, and, consequently, enclosed in narrow poriferous zones.

"3d. The *Pedina rotata*, Wright; assuredly very near to *Pedina Gervillii*, but distinguished from it by its more tumid form, its pores disposed more obliquely, its ambulacral tubercles smaller, closer set together, more numerous, and forming on the borders of the poriferous zones perfectly regular ranges. This last character suffices to distinguish *Pedina rotata* from young individuals of *Pedina sublevis*. We retain to this species the name *rotata*, with this observation, that in the figures of the 'Échinodermes de la Suisse' (pl. xv, figs. 4—6), the mouth is relatively smaller, and the ambulacral tubercles are more spaced out.

* 'Études sur les Échinides Fossiles,' p. 315.

"4th. The *Pedina aspera*, Agassiz, which is distinguished from the preceding species by its more granular aspect, by its principal tubercles being larger and more prominent, by its more numerous secondary tubercles, and by its poriferous zones being still more narrow than those of *Pedina Gervillii*."

M. Cotteau adds, that stratigraphical geology completely justifies these distinctions; *Pedina rotata* comes from the Inferior Oolite of England, *Pedina Gervillii* is met with in the Callovien stage of the Sarthe, *Pedina sublevis* characterises the inferior layers of the Coral Rag, and *Pedina aspera* appears to be special to the Kimmeridge Clay.

*Locality and Stratigraphical position.*—This species was first found in the upper ragstones of the Inferior Oolite, in a thin marly vein, which, in some places, rests on the Trigonia grit, in the same bed with *Ammonites Parkinsoni*, Sow. I have collected it from this stratum at Shurdington, Cold Comfort, and Hampen, in Gloucestershire; in the latter locality it is associated with *Holectypus depressus*, Leske, *Holectypus hemisphæricus*, Desor, *Echinobrissus Hugi*, Agass., *Echinobrissus clunicularis*, Llhwyd, *Clypeus sinuatus*, Leske, and *Stomechinus intermedius*, Agass. The Rev. A. W. Griesbach has discovered two fine large specimens in the Cornbrash of Rushden, Northamptonshire. Professor M'Coy gives the Great Oolite of Minchinhampton as the locality for the specimen in the Cambridge Museum. The specimen, figured in the 'Memoirs of the Geological Survey' was found in the upper beds of the Inferior Oolite, at Hampen, in the same bed from whence the specimens figured in Pl. XIII were obtained.

PEDINA SMITHII, *Forbes*. Pl. XIII, fig. 2 *a*, *b*, *c*.

CIDARIS, sp. 2 of William Smith's Stratigraphical System of Organized Fossils, p. 109.
ECHINOPSIS SMITHII. Forbes, Memoirs of the Geological Survey, Decade V, pl. 3. Notes on British Echinopsis.
— — Morris, Catalogue of British Fossils, 2d edit., p. 78.

Test pentagonal, much depressed; ambulacral areas narrow, and extremely prominent, with two rows of tubercles, which closely alternate in the lower half of the area, but abruptly cease on the upper half; inter-ambulacral areas wide, with two rows of primary tubercles, which occupy the zonal sides of the plate, and form a continuous series from the mouth to the disc, and two short secondary rows, which extend from the peristome to the circumference, where they abruptly cease; the miliary zone is wide, and covered with numerous granules, among these several small perforated tubercles occur; mouth opening large, peristome with deep incisions, and unequal-sized lobes.

*Dimensions.*—Height, about one inch; transverse diameter, nearly two inches.

*Description.*—I only know two fragments of this remarkable *Pedina*, the one (fig. 2 *a*) was collected by the late Dr. William Smith from the Inferior Oolite at Tucking Mill, the other (fig. 2 *c*) I found in the Inferior Oolite, near Birdlip. The description given by Dr. William Smith of this species was the following :

"Pentangular, depressed, with projecting and rather distant small mamillæ ; two contiguous rows in each areola, and four converging rows in each area, the two middle rows short, and only on the side or widest part of the area ; rough, with small points encircling the mamillæ ; rays obliquely triporous.

"The areolæ form the angles of the pentagon. The two larger rows of mamillæ in each area are parallel to the rays, and converge to the aperture, and the space between them on the side is occupied by two shorter converging rows.

"*Locality.*—Tucking Mill."

Dr. Smith's specimen is a fragment (fig. 2 *a*) which exhibits a part of two inter-ambulacral and an ambulacral area, the upper surface is concealed, and only two of the notches of the peristome are exposed ; the other specimen (fig. 2 *c*) is smaller, but shows more of the form and structure of the test. The ambulacral areas are narrow and straight ; their two rows of tubercles, which are nearly as large as those of the inter-ambulacra, closely alternate (fig. 2 *b*) between the peristome and the circumference, but as suddenly disappear from the upper part of the area (fig. 2 *c*).

The poriferous zones are wide, extremely so below (fig. 2 *a*), where the trigeminal ranks lie at angles of from 15° to 45° (fig. 2 *b*), above the ranks are more oblique, and wider apart, but throughout, the pores are always arranged in triple oblique pairs.

The inter-ambulacral areas are upwards of three times the width of the ambulacral ; from the peristome to the equator each of the inter-ambulacral plates has two tubercles developed on its surface (fig. 2 *b*), the primaries occupy the zonal sides of the plates, and the secondaries their outer margin ; the primary tubercles, nine or ten in each row, are raised on very prominent bosses (fig. 2 *b*), encircled by smooth well-defined areolas, around which circles of small granules are disposed (fig. 2 *b*) ; as the tubercles are placed very near the ambulacra, and the secondaries are absent on the upper surface, there is an unusually wide miliary zone in this region of the test, which is filled with numerous small granules, among which some minute perforated tubercles are interspersed (fig. 2 *b*).

The upper surface of the specimen (fig. 2 *a*) is covered with an extremely hard rock, that of fig. 2 *c* shows the opening for the apical disc, which is of moderate width. Only two of the notches of one angle of the mouth (fig. 2 *a*) are exposed ; they are deep, and have reflected edges ; the peristome is unequally lobed, and those of the ambulacra are much the largest.

*Affinities and differences.*—The only urchin which this species resembles is *Hemipedina Bakeri*, Pl. X, fig. 1 ; the mode in which the tubercles closely alternate in the ambulacra, and the proximity of the primary tubercles to the poriferous zones, show the near

affinity which exists between them; it is not improbable that a series of specimens might prove *H. Bakeri* to be the young condition of *Pedina Smithii*, although, in the present state of our knowledge of these forms, I should not be justified in stating such to be the fact.

*Locality and Stratigraphical position.*—The large fragment (fig. 2 *a*) was collected by the late Dr. William Smith, at Tucking Mill, in Moreton Combe, south-east of Bath, from a rock which I take to be Inferior Oolite. The specimen (fig. 2 *c*) I collected from the Inferior Oolite at Birdlip, near Cheltenham; it is the only specimen of the species I have found.

*History.*—As this is one of the Echinodermata belonging to Dr. Smith's original geological collection, deposited in the British Museum, its history is more than usually interesting. My friend, Mr. Woodward, first called Professor Forbes's attention to the specimen, who named it in honour of the father of English geology. In the description of the species, however (Notes on British *Echinopsis*, in the 'Memoirs of the Geological Survey,' Decade V), it is erroneously stated to have been collected from the Coral Rag, instead of from the Inferior Oolite. This remarkable form is now figured for the first time.

# NOTES

## On Foreign Jurassic species of the genus PEDINA nearly allied to British forms, but which have not yet been found in the English Oolites.

Pedina arenata, *Agassiz.* Échinoderm. Foss. Suisse, II, tab. xv, figs. 1—3.

Test small, hemispherical, flat at the base, convex on the upper surface; ambulacra with two rows of marginal tubercles, placed apart and separated by fine granules; poriferous zones very narrow, trigeminal ranks nearly upright; inter-ambulacra with two rows of small primary tubercles, secondary tubercles very small and scarcely apparent, except on the under surface; miliary granulation more abundant and distinct than in the other species; centro-sutural line naked and conspicuous; mouth opening proportionately large, two fifths the diameter of the test, peristome decagonal, and only slightly notched; the size of the mouth opening distinguishes it from other *Pedinas.*

*Dimensions.*—Height, six tenths of an inch; transverse diameter, one inch.

*Formation.*—Collected from the Inferior Oolite (Bajocien) of Goldenthal (Jura Soleurois).

*Collection.*—M. Gressly, very rare.

Pedina Gervillii, *Desmoulins.* Tableaux synonymiques des Échinides, p. 316, No. 19.

Test sub-pentagonal, depressed; ambulacra with two marginal rows of granules, placed wide apart, a larger and smaller tubercle alternating on the same row; in the structure of the ambulacra the difference between this species and *Pedina rotata* is chiefly observed; inter-ambulacra with two rows of primary and four rows of small secondary tubercles; poriferous zones narrow, pores largely open, trigeminal ranks slightly oblique, mouth opening small, peristome decagonal and deeply notched; apical disc moderate in size, genital plates nearly equal.

*Dimensions.*—Height, thirteen twentieths of an inch; transverse diameter, one inch and one quarter.

*Formation.*—Abundant in the "Callovien étage de Chauffour (Sarthe)." Triger.

*Collections.*—MM. Michelin, Desmoulins, Cotteau, de Lorière, Triger. My cabinet.

Pedina sublevis, *Agassiz.* Échinoderm. Foss. Suisse, II, tab. xv, figs. 8—13.
— — *Cotteau.* Études sur les Échinides Fossiles, pl. 26, figs. 1—6.
— — *Bronn.* Lethæa Geognostica, dritte Auflage, tab. xvii, fig. 10.

Test circular, shell extremely thin, equally depressed at both surfaces; ambulacra with two rows of small tubercles, spaced widely apart, and accompanied by secondary tubercles; inter-ambulacra three times as wide as the ambulacra, with two rows of primary, and four rows of secondary tubercles nearly as large as the primaries; tubercles of both areas nearly of the same size, and placed wide apart; poriferous zones rather wide, trigeminal ranks very oblique below, nearly vertical above; mouth opening small, peristome decagonal, and deeply notched.

*Dimensions.*—Height, seven tenths of an inch; transverse diameter, two inches.

*Formation.*—Corallien (Terr. à Chailles) des Ravières près de Locle, Val-de-Travers (Jura Neuchâtelois). *Desor.*—Dans les couches calcareo-siliceuses de Châtel-Censoir et de Druyes. *Cotteau.* This species is the most abundant of the genus, and is widely distributed through the Corallian stage of France, Germany, and Switzerland.

*Collections.*—MM. Michelin, Cotteau, and in most Continental museums. British Museum.

Pedina Michelini, *Cotteau.* Études sur les Échinides Foss., pl. 23, figs. 2—4.

Mould much inflated, and sub-pentagonal, slightly depressed at both poles; inter-ambulacra very wide, with a median depression; ambulacra very narrow; poriferous zones very narrow, trigeminal ranks nearly straight; test unknown. This species is found always as a siliceous mould.

*Dimensions.*—Height, one inch and seven twentieths; transverse diameter, two inches.

*Formation.*—"Dans les couches calcareo-siliceuses de l'étage Corallien inférieur, à Châtel-Censoir et à Druyes." *Cotteau.*

*Collections.*—Abundant. My cabinet.

PEDINA CHARMASSEI, *Cotteau.* Études sur les Échinides Foss., pl. 24, figs. 1—3; pl. 25, figs. 1—3.

Test large, extremely thin, sub-circular; hemispherical and inflated on the upper surface, flattened on the under surface; ambulacra with two rows of tubercles, as large as those in the inter-ambulacra, set closely and regularly together, on the extreme margins of the area; the intermediate miliary zone covered with fine granulations, poriferous zones wide, trigeminal ranks very oblique; inter-ambulacra four to five times the width of the ambulacra, with four rows of primary tubercles, which extend very regularly from the mouth to the summit; tubercles small, slightly developed, well spaced out, and accompanied with secondary tubercles almost as large, and which form, at the inferior surface, and towards the circumference of the test, some irregular rows, extending to the upper surface; mouth opening small, peristome divided by wide notches into ten unequal lobes.

*Dimensions.*—Height, two and a half inches; transverse diameter, four inches and a quarter.

*Formation.*—"Dans les couches calcareo-siliceuses subordonnées au Coral-rag inférieur, avec *Pedina Michelini* et *sublevis* presque toujours à l'état de moule intérieur siliceux." *Cotteau.*

*Collection.*—M. Cotteau, very rare; plaster mould in my cabinet.

PEDINA ASPERA, *Cotteau.* Études sur les Échinides Foss. pl. 44, figs. 7—12.

Test circular, thin, nearly equally depressed at both poles; ambulacra with two rows of marginal, well-spaced-out tubercles; inter-ambulacra thrice as wide as the ambulacra, with two rows of primary tubercles, larger and more developed than in other *Pedinas*, and surrounded by areolas; several secondary tubercles scattered over the surface of the plates; poriferous zones narrow, trigeminal ranks not very oblique; mouth opening small, peristome not deeply notched.

*Dimensions.*—Height, nine twentieths of an inch; transverse diameter, one inch and one tenth.

*Formation.*—" Le *Pedina aspera* caractérise les couches inférieures du Kimmeridge ; nous l'avons rencontré dans les marnes de Baroville et des Riceys (Aube), où il est assez rare. M. Royer nous en a communiqué deux échantillons fort beaux recueillis par lui dans le Kimmeridge inférieur de Marbeville (Haute Marne)." *Cotteau.*

*Collections.*—MM. Cotteau, Royer.

## *Family* 4—ECHINIDÆ.

This extensive natural family comprehends many genera of living and fossil urchins: some of which are large and globular; others are of moderate size, or small, hemispherical, or depressed: in general the test is thin, and each column is composed of a considerable number of plates.

The ambulacral areas are about one third the width of the inter-ambulacral; they have two, four, or more rows of tubercles developed on their surface, which are often nearly as large as those of the inter-ambulacral areas.

The poriferous zones present considerable diversity in the number and arrangement of the pores: in one section they are in single pairs; in a second they form double rows; in a third they are in triple oblique pairs; and in a fourth the wide poriferous zones have the pores disposed in three vertical rows.

The inter-ambulacral areas are more or less wide, and their large pentagonal plates are four times as long as they are broad; they are sometimes perforated at the angles, as in *Mespilia* and *Microcyphus;* or they have depressions in the line of the sutures, as in *Temnechinus* and *Opechinus;* the surface is sometimes sculptured with irregular figures in relief, as in *Glypticus*, or finely and microscopically plaited as in *Codiopsis;* for the most part the plates have numerous tubercles developed on their surface.

The tubercles are in general small, and nearly of the same size in the ambulacral and inter-ambulacral areas; their bosses have smooth summits, and they are always imperforate; there are often several rows on the same horizontal line.

The spines are always short and subulate, and their surface is sculptured with fine longitudinal lines.

The mouth opening is sometimes small, and sometimes very large; the peristome is often pentagonal, and feebly indented; or it is deeply incised, and divided by notches into unequal-sized lobes.

The apical disc is small, and composed of five genital and five ocular plates; the spongy madreporiform body is always prominent on the right antero-lateral genital plate.

The large and powerful jaws are composed of the same pieces as in the *Cidaridæ;* but the pyramids are excavated in their upper part, and the two branches are united by an arc at the summit: the teeth are long and tricarinated.

In the following table I have endeavoured to classify the genera, and to show at one view the most striking characters of the different groups included in this family:

A Table showing the Classification of the ECHINIDÆ.

| Family. | Sections. | | Diagnosis. | Genera. |
|---|---|---|---|---|
| Echinidæ. | Section A. | Poriferous zones very narrow. Pores in single pairs. | Inter-ambulacra with irregular sculptured plates on the upper surface of the test. | Glypticus, *Agassiz.* |
| | | | Upper surface of both areas finely plaited; large tubercles at the base only; mouth small. | Codiopsis, *Agassiz.* |
| | | | Plates of both areas with pyriform depressions in a portion of the line of the sutures; ambulacra wide. | Temnechinus, *Forbes.* |
| | | | Plates with deep depressions along the whole line of the sutures; ambulacra narrow; mouth small. | Opechinus, *Desor.* |
| | | | Numerous small, equal-sized tubercles in both areas; two rows in the ambulacra, and four to ten in the inter-ambulacra. | Echinocidaris, *Desmoulins.* |
| | | | Surface granular, with numerous small, close-set tubercles; mouth small; peristome feebly indented. | Cottaldia, *Desor.* |
| | | | Inter-ambulacra lobed, with numerous small, close-set tubercles; mouth large; peristome pentagonal. | Magnotia, *Michelin.* |
| | Section B. | Poriferous zones narrow. Pores in double rows. | Both areas naked in the middle, tubercles on the sides, with sutural pores, and a tuberculous base. | Mespilia, *Desor.* |
| | | | Tubercles numerous, equal-sized, sporadic; inter-ambulacra with naked horizontal spaces in the line of the sutures; angular pores. | Microcyphus, *Agassiz.* |
| | Section C. | Poriferous zones wide. Pores in triple oblique pairs. | Tubercles small, limited to the sides of the areas; test globular, with a very small pentagonal mouth. | Codechinus, *Desor.* |
| | | | Tubercles small, numerous, equal-sized, in vertical and horizontal rows; larger at the base; mouth large, pentagonal. | Polycyphus, *Agassiz.* |
| | | | Tubercles numerous, in many unequal, vertical rows; mouth moderate; peristome feebly notched. | Psammechinus, *Agassiz.* |
| | | | Tubercles numerous, same size in both areas; mouth small; peristome with deep, narrow slits. | Echinus, *Linnæus.* |
| | | | Tubercles unequal, two or more rows in each area, with secondaries; mouth very large, pentagonal, with wide, deep notches. | Stomechinus, *Desor.* |
| | Section D. | Poriferous zones very wide. Pores in three vertical rows. | Tubercles small, irregular, sporadic; middle of the ambulacra naked; pores at the angles of the plates. | Amblypneustes, *Agassiz.* |
| | | | Tubercles small, numerous; the inner row of pores separated from the two outer rows by a line of tubercles. | Boletia, *Desor.* |
| | | | Tubercles not prominent; the outer and inner rows of pores rectilinear and regular, the middle row irregular. | Tripneustes, *Agassiz.* |

*Genus*—GLYPTICUS, *Agassiz*. 1840.

The urchins grouped in this small genus constitute a type which is easily recognised, although in an organic point of view their most striking external character is not of the first value; in fact, the irregular structure of the tubercles of the inter-ambulacral areas essentially determines the peculiar physiognomy of the genus.

The small urchins composing this genus have a thick test, and a round, depressed, or sub-conoidal form; the ambulacral areas are narrow and straight, with two rows of marginal tubercles, very regularly arranged throughout.

The poriferous zones are narrow, and the pores strictly unigeminal.

The inter-ambulacral areas have two rows of well-developed tubercles at their base; but on the upper part of the area the regular tubercles disappear, and the surface of the plates is deeply sculptured with remarkable figures, which, in some species, resemble hieroglyphical characters.

The apical disc is large; the genital plates are prominent, and have their surface sculptured; the eye-plates are large, and the lines of division between the plates are very strongly marked.

The mouth opening is wide; the peristome decagonal, the notches are shallow, and the lobes very unequal.

The tubercles of both areas are imperforate, and have smooth, uncrenulated bosses.

*Glypticus* resembles *Temnopleurus* in having the plates sculptured on the upper surface; but in the former the figures are in relief, whilst in the latter the sculpture consists of deep impressions corresponding to a portion of the sutures of the ambulacral and inter-ambulacral areas. In *Temnopleurus* the tubercles form regular rows, and are crenulated, but imperforate; the poriferous zones are undulated, and the pores are in threes. *Glypticus* was thought to resemble *Cyphosoma*, but I cannot detect any two characters in common in these genera. In *Cyphosoma* the tubercles are regular, and well developed throughout; they have distinct areolas, crenulated bosses, and imperforate summits; the poriferous zones are undulated, and the pores bigeminal in the upper part of the zones.

*Glypticus* is distinguished from *Pseudodiadema* in the irregular sculpture on the inter-ambulacra, and in having the tubercles imperforate and uncrenulated. It resembles one section of that genus, however, in having the pores unigeminal in the zones.

*Glypticus* resembles *Stomechinus* in having the tubercles imperforate, and with smooth bosses; but is easily distinguished by the sculpture on the plates, and the size and foliated character of the apical disc.

The species of this genus have been hitherto found only in the Oxford Clay, Coral Rag, and Portland beds, so that it belongs to the Middle and Upper divisions of the Oolitic group.

GLYPTICUS HIEROGLYPHICUS, *Goldfuss*. Plate XIII, fig. 3 *a, b, c, d, e, f*.

| | |
|---|---|
| GLYPTICUS HIEROGLYPHICUS. | Bourguet, Traité des Pétrifications, pl. 51. fig. 377 (1742). |
| — — | Knorr, Recueil des Monuments des Catastrophes, que le globe terrestre a essayées, contenant des Pétrifications, tabl. E ii, No. 35, fig. 3, 1775. |
| ECHINITES TOREUMATICUS. | Leske, Additamenta ad Kleinii dispositionem Echinodermatum, p. 156, pl. 44, fig. 2, 1778. |
| ECHINUS HIEROGLYPHICUS. | Goldfuss, Petrefacta Germaniæ, p. 126, tabl. 40, fig. 17, 1829. |
| ARBACIA HIEROGLYPHICA. | Agassiz, Prodrome d'une Monographie des Échinodermes, p. 23, 1836. |
| ECHINUS HIEROGLYPHICUS. | Desmoulins, Tableaux synonymiques des Échinides, No. 60, p. 292, 1837. |
| — — | Lamarck, Animaux sans vertèbres, 2de édit., tome iii, p. 372, No. 43, 1840. |
| GLYPTICUS HIEROGLYPHICUS. | Agassiz, Catalogus systematicus ectyporum Echinodermatum fossilium, p. 13, 1840. |
| — — | Agassiz, Échinodermes Fossiles de la Suisse, 2e partie, p. 96, pl. 23, figs. 37—39, 1840. |
| — — | Bronn, Index Palæontologicus, p. 186, 1849. |
| — — | Agassiz and Desor, Catalogue raisonné des Échinides. Annales des Sciences Nat., 3me série, tome vi, p. 360, 1846. |
| | Bronn, Lethæa Geognostica, 3tte Auflage, Band ii, p. 146, pl. 17, fig. 4, 1851. |
| — — | D'Orbigny, Prodrome de Paléontologie stratigraphique universelle, tome ii, p. 26, 14th étage, No. 420, 1850. |
| — — | Quenstedt, Handbuch der Petrefactenkunde, p. 581, 1852. |
| — — | Cotteau, Études sur les Échinides Fossiles, p. 166, pl. 20, figs. 12—15, 1852. |
| — — | Desor, Synopsis des Échinides Fossiles, p. 95, tabl. 16, figs. 1—3. |

Test thick, circular, flattened at the base, hemispherical on the upper surface, subdepressed; ambulacral areas narrow, straight, with two rows of marginal tubercles; poriferous zones deeply sunk, pores unigeminal; inter-ambulacral areas wide, with two rows of tubercles at the base; on the upper surface the plates are deeply sculptured with irregular, hieroglyphic-like figures; tubercles imperforate and bosses smooth; apical disc large; genital plates elongated, with a sculptured surface, holes near the outer fourth; ocular plates triangular, holes marginal; mouth opening large, peristome decagonal, lobes unequal, notches small.

*Dimensions.*—Height, eleven twentieths of an inch; transverse diameter, one inch and one tenth.

*Description.*—This urchin has been long known to naturalists, having been figured by Bourguet and Knorr in their respective works, cited in the synonymy. Leske, however, in his 'Addimenta ad Kleinii Echinodermatum,' first described this curious form under the name *Echinus toreumaticus,* and gave a figure of it in his pl. xliv, fig. 2. Some authors have confused this species with Klein's *Cidaris toreumatica,* which is quite a different urchin, and forms the type of Agassiz's genus *Temnopleurus.* Moreover, *Temnopleurus toreumaticus,* Klein, is living in the Persian Gulph, whilst *Echinus toreumaticus,* Leske, is found fossil only in the Coral Rag.

The ambulacral areas are narrow, and very well defined by the straight poriferous zones, which form deep furrows at their sides; they are about one fourth the width of the inter-ambulacral, and have two rows of round tubercles, about fifteen in each row, very regularly arranged on the margins of the areas (fig. 3 *f*); the tubercles at the base are much larger, and more prominent; and on the upper surface, a zigzag line of granules separates the marginal tubercles (fig. 3 *f*).

The poriferous zones are narrow and straight, and, in consequence of the thickness of the sculptured plates, lie deeply sunk; the pores are unigeminal and oblique (fig. 3 *f*), and there are seven pairs of pores opposite each inter-ambulacral plate; near the peristome they are in ranks of threes.

The inter-ambulacral areas are four times as wide as the ambulacral; from the peristome to the equator there are two rows of large, round tubercles, on smooth, prominent bosses (fig. 3 *a*, *b*, *c*); and around the areolas circles of granules are disposed (fig. 3 *f*), which, when viewed in profile, are rather conspicuous (fig. 3 *e*). On the upper part of the areas the plates exhibit a most singular structure (fig. 3 *b*, *f*); around the primary tubercles there are a number of irregular elevations, in relief, resembling hieroglyphic characters (fig. 3 *f*); and although there is a considerable uniformity in the general *facies* of the sculpture, still scarcely are any two figures alike (fig. 3 *b*, *f*). It is this structure which suggested Leske's name, *toreumaticus,** and Goldfuss's name, *hieroglyphicus.* The plates are thick and broad, and there are only about seven in each column; the tubercles at the base (fig. 3 *a*) are round, regular, and prominent, and form a remarkable contrast to the toreumatic sculpture exhibited on the upper part of the areas.

The apical disc is large, and forms a prominence on the vertex; it is one third the diameter of the test at the equator (fig. 3 *b*); the genital plates have an elongated, heptagonal form, and are sculptured on the surface like the plates of the inter-ambulacral areas; the oviductal hole is pierced about the outer third (fig. 3 *d*); the ocular plates are prominent and heart-shaped, the eye-hole is marginal, and the sutural lines between all the elements of the disc are defined by deep depressions (fig. 3 *d*); the vent is sub-pentagonal, and the madreporiform body is represented by a few granules on the surface of the right antero-lateral genital plate.

* *Toreuma,* (τόρευμα,) any work raised in relief.

The mouth opening is one half the diameter of the test, the peristome is unequally decagonal, the notches are small, and the ambulacral are nearly twice as wide as the inter-ambulacral lobes.

*Affinities and differences.*—As this is the only species of the genus *Glypticus* found in the English Oolites, it is impossible to mistake it: the thick test, with the hieroglyphic-like markings on the plates of the inter-ambulacral areas, and of the genital disc, distinguish it sufficiently from all others.

*Locality and Stratigraphical position.*—The rich cabinet of the late Mr. Channing Pearce contains three specimens of this species, collected from the Coral Rag of Calne, Wilts; and in the Museums of York and Whitby I saw one specimen in each, which were collected from Coralline Oolite of Malton.

In France, M. Cotteau collected it at Châtel-Censoir and Druyes from the Inferior Coral Rag, and the calcareo-siliceous layers subordinate to it. According to M. Desor it is found in the Corallien (Terrain à chailles) of the Swiss and French Jura, of Burgundy, Württemberg, and Franconia. On the Continent it is a very abundant and characteristic fossil of the Coral Rag, and is now recorded for the first time as a British urchin.

*History.*—Leske appears to have considered this species identical with *Cidaris toreaumatica,* Klein, he says, "Convenit hic Echinites omnino cum ipsa naturali Cidari toreumatica, figura testae lineolis insculptis, ambulacris biporosis et ani structura, ut nulla mihi relinquatur dutitatio, cum hujus esse speciei. Testa est calcareo spatosa, coloris cinereo flavescentis; nucleus calcareus griseus. In *Lotharingia* inventus est."*

Goldfuss figured and described it in his 'Petrefacta Germaniæ' by the name *Echinus hieroglyphicus.* M. Agassiz, in his 'Prodrome,' placed it in the genus *Arbacia,* but afterwards, in his 'Échinodermes Foss. de la Suisse,' proposed for this and other congeneric forms, the genus *Glypticus.* In this work it is beautifully figured, and described in detail as *Glypticus hieroglyphicus.* It has lately been figured by Bronn in his 'Lethæa,' by M. Cotteau in his 'Études sur les Échinides Fossiles,' and by M. Desor in his 'Synopsis des Échinides Fossiles,' and is now recorded for the first time as a British fossil urchin.

* 'Additamenta ad Kleinii dispositionem Echinodermatum,' p. 156, pl. 44, fig. 2.

# NOTES

## On Foreign Jurassic species of the genus GLYPTICUS, nearly allied to the British form, but which have not yet been found in the English Oolites.

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Glypticus Burgundiacus, *Michelin.* Revue et Magasin de Zool., No. 1, 1853. "A large and fine species: it has, below the irregular portion of the inter-ambulacral areas, three or four very large tubercles.

"*Formation.*—Oxfordien ferrugineux d'Estrochey près Chatillon-sur-Seine.

"*Collection.*—Museum of Dijon: very rare." *Desor.*

Glypticus sulcatus, *Goldfuss.* Syn. *Echinus sulcatus*, Goldfuss. Petrefact. Germaniæ, tabl. 40, fig. 18.

A small hemispherical urchin, with a flat base; tubercles very irregular; on each inter-ambulacral area there are two deep grooves; the apical disc is large.

*Formation.*—Coral Rag, Nattheim; Engelhardsberg (Franconia); the environs of Vendôme.

*Collections.*—Museums of Munich, Tübingen, all foreign collections: very common.

*Genus*—MAGNOTIA, *Michelin.* 1853.

This genus was established by M. Michelin* for small urchins, closely resembling *Polycyphus*, but which are distinguished from that genus by the arrangement of the pores in the zones. The genus is thus defined by its learned author:

Test elevated, inflated, with a concave base, and numerous small, equal-sized, imperforate and uncrenulated tubercles in both areas.

The pores are disposed in single pairs from the disc to the circumference; from thence to the peristome they become crowded, and form many series.

The mouth is very large, and occupies much of the base; the peristome is unequally decagonal, and, from the width of the ambulacral lobes, is almost pentagonal.

The apical disc is small, and the vent round.

The ambulacral areas are narrow; the inter-ambulacral areas have a deep median depression, so that the test is divided into fifteen unequal lobes, of which the five ambulacral are the smallest. In both areas the tubercles are arranged in oblique ranks.

The distinctive structural character between *Magnotia* and *Polycyphus* consists in the arrangement of the pores, which are in simple pairs in *Magnotia*, and form triple oblique pairs in *Polycyphus:* in all other respects these urchins closely resemble each other.

The only English species of this small group was referred by me to the genus *Arbacia* of Agassiz, when I first described it in my 'Memoirs on the Cidaridæ of the Oolites;'† but as there is much doubt about the true characters of that genus, I have placed it in M. Michelin's *Magnotia*, of which it forms a good type.

*Arbacia* was a small group of the Echinidæ, proposed by Dr. J. E. Gray, in October, 1835,‡ for a section of the genus *Echinus*, now living, in which, according to this author, the body is depressed, the ambulacral areas are very narrow, the poriferous zones narrow and straight, the pores in simple pairs, the ovarian and inter-ovarian plates middle sized, and the anus covered by four valves. The types of the genus cited by the author are *Echinus pustulosus*, Leske, and *Echinus punctalatus*, Lamk.

M. Desmoulins,§ in 1834, had proposed the genus *Echinocidaris* for the same group, and which he thus defined: "General form perfectly regular, circular; upper surface depressed; under surface slightly concave; areas very unequal; ambulacra always less than one half the width of the inter-ambulacra; ambulacra complete, lanceolate, straight,

* 'Revue et Magasin de Zoologie,' No. 1, 1853.

† 'Annals and Magazine of Natural History,' 2d series, vol. viii, p. 278.

‡ 'Proceedings of the Zoological Society,' part iii, p. 58; and 'Philosophical Magazine,' 3d series, vol vii, p. 329, Oct., 1835.

§ 'Tableau analytique des genres d'Échinides,' July, 1834. 'Études sur les Échinides,' p. 14.

bordered on each side with a single pair of pores; spiniferous tubercles as in Echinus." The six species included in this genus are all living.

M. Agassiz's* definition of *Arbacia* differs very materially from that of the original author. He confines it to "small, sub-spherical urchins, having the test covered by numerous, small, smooth-based, imperforate tubercles, ranged in numerous rows on the inter-ambulacral, and sometimes on the ambulacral areas. Pores disposed in simple pairs. Mouth circular, without deep notches. Apical disc narrow and ring-like." All the species enumerated in the 'Catalogue raisonné' are Cretaceous and Tertiary fossils, and the *Arbacia* of Gray are transferred to the genus *Echinocidaris*, Desml., so that the *Arbacia* of Agassiz is not the *Arbacia* of Gray, but a new group which required revision and a distinct name. To avoid future confusion, one section now forms the genus *Cottaldia*, Desor, another the genus *Magnotia*, Michelin, whilst the original *Arbacia* of Gray are placed in the *Echinocidaris* of Desmoulins, as that genus was first established.

MAGNOTIA FORBESII, *Wright*. Pl. XIII, fig. 6 *a*, *b*, *c*, *d*, *e*, *f*.

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|---|---|
| ARBACIA FORBESII. | Wright, Annals and Magazine of Natural History, 2d series, vol. viii, p. 278, pl. 13, fig. 4. |
| ECHINUS FORBESII. | Morris, Catalogue of British Fossils, 2d edit., p. 79. |
| — — | Salter, Memoirs of the Geological Survey, Decade V, description of pl. 4. |
| MAGNOTIA FORBESII. | Desor, Synopsis des Échinides Fossiles, p. 115. |

Test small, hemispherical, sub-pentagonal; ambulacral areas straight, narrow, and of uniform width throughout, with four rows of small, equal-sized, close-set tubercles; poriferous zones narrow, and sunk in a groove; pores unigeminal throughout; inter-ambulacral areas wide, each divided into two lobes by a median depression, the surface of the plates covered with numerous close-set, equal-sized tubercles; base concave; mouth-opening large, situated in a depression; apical disc small, prominent, and ring-shaped.

*Dimensions.*—Height, nine twentieths of an inch; transverse diameter, three quarters of an inch.

*Description.*—The test of this beautiful sub-pentagonal little urchin is divided into fifteen unequal lobes; five of these, forming the ambulacral areas, are narrow, and ten much wider, the divided inter-ambulacral areas, which have deep furrows corresponding to the centro-sutural line, and dividing each area into two equal convex conical lobes; the

* 'Catalogue raisonné des Échinides, Annales des Sciences Naturelles,' 3$^{me}$ serie, tome vi, p. 355.

entire surface of the plates of all the areas is covered with small, smooth, polished, equal-sized tubercles, crowded closely together, and disposed in oblique lines (fig. 6*f*).

The ambulacral areas are narrow and prominent, and nearly of the same width throughout; they are furnished with four rows of tubercles, except at the apex of the area, where there are only two rows (fig. 6*f*).

The poriferous zones form narrow, depressed, well-defined lines on the surface of the test (fig. 6 *d*); the pores are small, and strictly unigeminal throughout, and there are four pairs of pores opposite each inter-ambulacral plate (fig. 6*f*).

The inter-ambulacral areas are upwards of four times the width of the ambulacral; each of these spaces is divided into two convex lobes by a well-defined longitudinal depression, which extends from the base to the disc in the direction of the sutural line; the narrow ambulacra, bounded by the deep poriferous zones, and the wide inter-ambulacra, divided by median depressions, produce a remarkable lobed appearance on the test of this little urchin (fig. 6 *a*, *b*); the surface of the areas is crowded with small, smooth, equal-sized tubercles; at the circumference there are from twenty-five to thirty rows (fig. 6*f*), but the number diminishes at the upper surface, where the areas contract, and likewise at the base, where the tubercles are larger; it may be stated, as a general character of this species, that the tubercles are crowded so close together in all the areas that the surface of the plates is rendered invisible, and the test, when examined with a lens, has a uniform granulated appearance (fig. 6 *c*, *d*).

The base is concave (fig. 6 *c*), and the tubercles are larger in this region; the mouth opening is wide, and lies in a depression; the peristome has a pentagonal form, from the unequal size of the lobes. The notches are not well exposed in the only good specimen I possess.

The apical disc is small and prominent (fig. 6 *a*, *b*); it has a ring-like shape, from the smallness of the ovarial plates and the size and position of the oculars (fig. 6 *e*); the anterior pair of ovarials are the largest, and the right plate carries a small spongy madreporiform body; the vent is transversely oblong (fig. 6 *e*), and the oviductal holes are large.

*Affinities and differences.*—This urchin, at first sight, might be mistaken for *Polycyphus Normannus*, Desor, from the Great Oolite, but it is more depressed and pentagonal, has a more concave base, deeper areal depressions, smaller, more numerous, and closer-crowded tubercles; the ambulacra are narrower, and the pores in the zones are unigeminal. These characters are sufficiently marked to prevent *Magnotia Forbesii* being mistaken for *Polycyphus Normannus*: *Magnotia* has the zones narrow and the pores unigeminal, *Polycyphus* has the zones wide and the pores trigeminal.

*Locality and Stratigraphical position.*—This very rare urchin was collected in the upper ragstones of the Inferior Oolite, at Dundry, near Bristol. The two specimens in

my collection, and the fine series in the Bristol Museum, with one found by Mr. W. H. Baily, are the only specimens I know.

*History.*—First figured as *Arbacia Forbesii,* in my 'Memoir on the Cidaridæ of the Oolites.' It was afterwards referred by M. Desor, in his Synopsis, to the genus *Magnotia,* and appears to form a good type of that new group; it is the only English example of the genus we at present possess.

# NOTES

## On Foreign Jurassic species of the genus MAGNOTIA, nearly allied to the British form, but which have not yet been found in the English Oolites.

Magnotia Nodoti, *Michelin.* Rev. et Mag. Zool., No. 1, 1853.

Test hemispherical; ambulacra narrow, with four rows of tubercles; inter-ambulacra with twelve rows; tubercles of both areas of a uniform size, and not sensibly increased at the circumference; mouth opening large, occupying the greater portion of the base.

*Formation.*—Inferior Oolite d'Avesne (Côte-d'Or).

*Collection.*—Museum of Dijon; a single specimen, which forms the type of this genus.

Magnotia nodulosa, *Münster.* Syn. *Echinus nodulosus,* Münst., in Goldfuss, Petrefact. Germ., tabl. 40, fig. 16.

Test nearly hemispherical, more or less sub-pentagonal; ambulacra with four rows of tubercles, diminishing to two; inter-ambulacra divided by a median depression, and furnished with from eight to ten rows, disposed in slightly arched horizontal lines; the tubercles are a little larger at the circumference, and much larger at the base; they are nearly uniform in size in both areas; mouth opening large; apical disc very narrow, in the form of a ring.

*Formation.*—Coral Rag of Baireuth, and Nattheim.

*Collections.*—Museums of Bonn, Tübingen.

Magnotia Jurassica, *Cotteau.* Syn. *Arbacia Jurassica,* Cotteau, Études sur les Échinides, pl. 20, figs. 6—11.

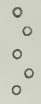
Test small, flat below, inflated above; ambulacra with four rows of tubercles; inter-ambulacra with ten rows; upper surface of the areas depressed, and naked in the middle; the horizontal series of tubercles in inclined rows; mouth opening large; peri-

stome slightly notched into ten nearly equal-sized lobes. This species is less granular than the preceding, from which it likewise differs in having smaller tubercles at the base.

*Formation.*—Inferior beds of "l'étage Corallien" at Châtel-Censoir (Yonne), d'Eccomoy (Sarthe).

*Collection.*—M. Cotteau: very rare.

MAGNOTIA DECORATA, *Agassiz.* Syn. *Eucosmus decoratus*, Agassiz. Cat. raisonné, Ann. Sc. Nat., 3$^{me}$ série, tome vi, p. 356, pl. 15, figs. 12, 13.

Test small, hemispherical, depressed; ambulacra so extremely narrow that there is only space for a single row of tubercles, arranged in a zigzag line, thus  ; inter-ambulacra wide, with eighteen rows of tubercles, which do not form vertical and horizontal series, but are arranged in oblique lines; the zigzag row of tubercles in the ambulacra results from the alternate plates in the area carrying only one tubercle on each.

*Formation.*—Argovien (Formation $\gamma$ of Quenstedt), Lægern, Baden near Zurich, Lochen (Württemberg).

*Collections.*—Museums Zurich, Neuchâtel, Bale.

## *Genus*—POLYCYPHUS, *Agassiz.* 1846.

This genus consists of small urchins, with a sub-globular or hemispherical form; the sides and upper surface of the test are covered with numerous, small, equal-sized, imperforate tubercles, which form numerous vertical and horizontal rows; at the base of both areas the tubercles are disproportionately large, when compared with those on the upper surface.

The poriferous zones are wide and depressed, and the pores are arranged in triple oblique pairs; near the peristome the pores are more numerous, and crowded.

The mouth opening is large; the peristome is pentagonal, the notches are shallow, with wide ambulacral, and short inter-ambulacral lobes.

The apical disc forms a narrow ring, and the genital and ocular plates are small.

The wide inter-ambulacral areas are each divided into two lobes by a slight median depression, so that the surface of the test in this genus is divided into fifteen nearly equal-sized lobes.

*Polycyphus* very much resembles *Magnotia* in the general *facies* of the species, in the size and ornamentation of the test, in its division by depressions into lobes, in the number of small imperforate tubercles which crowd its surface, and the ring-like character of the apical disc; but *Magnotia* is distinguished from *Polycyphus* by the narrowness of the ambulacral areas, and especially by having the pores strictly unigeminal throughout the narrow sunken, poriferous zones.

*Polycyphus* resembles *Stomechinus* in having the pores in triple oblique pairs; but is distinguished by the number and general uniform character of the tubercles, arranged in vertical and horizontal rows, and by having those at the base of the areas disproportionately large when compared with the small tubercles on the upper surface. In *Stomechinus* there is always a primary row of tubercles, and secondary rows; but in *Polycyphus* they are in general uniformly of the same size. The peristome in *Stomechinus* is always very deeply incised by large notches, whilst in *Polycyphus* the division of the peristome is but feebly marked.

POLYCYPHUS NORMANNUS, *Desor*. Pl. XIII, fig. 4 *a, b, c, d, e, f*.

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|---|---|
| POLYCYPHUS NODULOSUS. | Agassiz and Desor, Catalogue raisonné des Échinides, Annales des Sciences Naturelles, 3me série, tome vi, p. 361, pl. 15, fig. 18. |
| ARBACIA NODULOSA. | Wright, Annals and Magazine of Natural History, 2d series, vol. viii, p. 279, pl. 13, fig. 3 *a, b*. |
| POLYCYPHUS NODULOSUS. | Wright, Annals and Magazine of Natural History, 2d series, vol. xiii, p. 178. |
| ECHINUS NODULOSUS. | Morris, Catalogue of British Fossils, 2d edit., p. 79. |
| — — | Salter, Memoirs of the Geological Survey, Decade V, pl. 4, p. 8. |
| POLYCYPHUS NORMANNUS. | Desor, Synopsis des Échinides Fossiles, p. 117, tabl. 19, figs. 4—6. |

Test circular, hemispherical above, flattened at the base; ambulacral areas a little more prominent than the inter-ambulacral, with six rows of tubercles at the equator; inter-ambulacra with fourteen rows of tubercles disposed in vertical and transverse lines; tubercles of both areas smooth, round, and nearly of the same size; basal tubercles much larger; poriferous zones wide, pores in trigeminal ranks; inter-ambulacra divided by slight median depressions, and naked at the upper part of the centro-suture: apical disc small and ring-like; base flat; mouth opening large; peristome very unequally lobed.

*Dimensions.*—Height, seven twentieths of an inch; transverse diameter, eleven twentieths of an inch.

*Description.*—This pretty little urchin has been long confounded with *Magnotia nodulosa*, Münster, from the Coral Rag of Nattheim, which it resembles much in its general physiognomy, but is distinguished by the structure of its ambulacra and poriferous zones, the pores in *M. nodulosa* being unigeminal, whilst in *P. Normannus* they are trigeminal: for this reason M. Desor has properly described it as a distinct species. Its hemispherical test exhibits a disposition to assume a sub-pentagonal form, in consequence of the prominence of the ambulacral areas (fig. 4 *a, b*); the surface of the test is divided into fifteen nearly equal lobes by the ten wide poriferous zones, and a median depression in the centre of the inter-ambulacra (fig. 4 *e*); these lobular divisions are more marked in young and small specimens than in old and large ones; the ambulacral areas (fig. 4 *b, e*) are one half the width of the inter-ambulacral, they have nine large tubercles at their base (fig. 4, *e, f*), and six rows of small tubercles at their widest part (fig. 4 *e*), which gradually diminish to four and two rows above (fig. 4 *b*).

The inter-ambulacral areas are twice the width of the ambulacral (fig. 4 *b*), and are each divided by a median depression into two equal-sized lobes (fig. 4 *c*); they have from twenty to twenty-four large tubercles at their base (fig. 4 *c*), and from twelve to fourteen tubercles on the same line at their widest part (fig. 4 *e*), which gradually diminish by the disappearance of the lateral rows to ten, eight, six, four, and two (fig. 4 *b*); the row on

the centre of the plates alone extending from the peristome to the disc; the tubercles on the sides and upper surface of the ambulacra and inter-ambulacra are nearly of a uniform size, and regularly arranged in a series of horizontal and vertical rows (fig. 4 *f*), so that the tubercles are opposite each other, and do not alternate as in *Magnotia*.

The poriferous zones are wide and straight (fig. 4 *b*, *c*); the pores are arranged in oblique trigeminal ranks (fig. 4 *f*); at the base they are more crowded (fig. 4 *e*), to fill up the space between the ambulacral and inter-ambulacral areas.

The base is flat (fig. 4 *e*); the large mouth opening is nearly pentagonal, and lies in a concavity, surrounded by the larger tubercles which occupy this region (fig. 4 *c*); the peristome is feebly notched (fig. 4 *c*), and very unequally lobed, the ambulacral being three times the length of the inter-ambulacral lobes.

The apical disc is small and prominent (fig. 4 *b*); the genital plates are all nearly of the same size (fig. 4 *d*), and perforated near their apex; the ocular plates are small, and the eye-holes marginal; the vent is transversely oblong (fig. 4 *d*), and the genital plates form a prominent ring around it; the spongy madreporiform body is rather elevated, and a few microscopic granules adorn the surface of the plates.

*Affinities and differences.*—In its general *facies*, this little lobed and nodulated urchin resembles *Magnotia Forbesii*, but in the details of its structure it is very distinct from that form; thus its ambulacral areas and poriferous zones are wider, the median inter-ambulacral sulcus is shallower and not so defined, the tubercles are larger and arranged in a series of vertical and horizontal rows, and the pores are disposed in oblique trigeminal ranks; the test is likewise more hemispherical and inflated, and wants the marked sub-pentagonal outline, the narrow furrowed zones, and deep median sulci which so well characterise *Magnotia Forbesii*.

*Locality and Stratigraphical position.*—This species is very rare in England. I have collected one specimen from the Trigonia grit, Inferior Oolite, near Hampen; Mr. Jones found another near Birdlip, in the same rock; the Rev. P. B. Brodie collected one specimen from a bed of clay resting on the Stonesfield slate at Sevenhampton, associated with *Acrosalenia spinosa* and *Pecten varians;* Mr. Lycett obtained several from the Great Oolite of Minchinhampton Common; these are the only specimens known to me which have been collected in Gloucestershire. Mr. William Buy found a beautiful specimen in the Cornbrash near Sutton-Benger, Wilts, which is in my collection. He informs me that it is the only example of this urchin he has found. It was associated with *Acrosalenia hemicidaroides*, *Acrosalenia spinosa*, and other Cornbrash fossils; so that the range of this species is from the upper ragstones of the Inferior Oolite through all the intermediate beds into the Cornbrash, where it becomes extinct.

On the Continent it is more abundant. It has been collected from the Great Oolite of Langrune and Luc by Professor Deslongchamps and M. Tesson; and from the Calcaire à polypiers at Ranville by M. Michelin. I have to thank each of these gentlemen for the

beautiful series of type specimens they have sent me for comparison, and which are perfectly identical with our English forms.

*History.*—First entered in the 'Catalogue raisonné des Échinides' of Agassiz and Desor as *Polycyphus nodulosus*, under the supposition that it was identical with Münster's species from Nattheim; a more pentagonal form was afterwards figured by me in the 'Annals of Natural History,' under the name of *Arbacia nodulosa*. M. Desor has the merit of having shown that it is even generically distinct from the German urchin, which has narrow zones and unigeminal pores; whereas our species has wide zones, and the pores in oblique trigeminal ranks. M. Desor has therefore described and figured it as a distinct species, under the name *Polycyphus Normannus*.

Polycyphus Deslongchampsii, *Wright*. Pl. XIII, fig. 5 *a, b, c, d, e, f*.

Polycyphus Deslongchampsii. Wright, Annals and Magazine of Natural History, 2d series, vol. xiii, p. 179, pl. 12, fig. 4.
— — Morris, Catalogue of British Fossils; additional species of Echinodermata.

Test small, hemispherical, and circular; ambulacral areas with two rows of large, and two rows of smaller tubercles; inter-ambulacral areas divided into lobes by a median depression, and provided with two rows of large, and several rows of smaller tubercles, the small tubercles often degenerating into granules; basal tubercles large and prominent; apical disc prominent.

*Dimensions.*—Height, seven twentieths of an inch; transverse diameter, thirteen twentieths of an inch.

*Description.*—Amongst the many beautiful forms of Echinidæ found in the Oolitic rocks, this pretty little species will bear comparison for neatness and symmetry with any of the family to which it belongs. I first found a solitary specimen of this species about four years ago, and since then have obtained an interesting series of different ages; but it is a very rare species.

The ambulacral areas are one half the width of the inter-ambulacral (fig. 5 *b, d*); they have two rows of tubercles set closely and regularly together on the extreme margins of the areas (fig. 5 *b, f*); between these are two shorter, inner rows, which do not extend more than two thirds the length; at the base of the area ten large tubercles are disposed

in pairs (fig. 5 *c*, *d*), those on the right alternating with those on the left side of the area.

The inter-ambulacral areas are twice the width of the ambulacral (fig. 5 *b*, *d*) ; a single row of larger tubercles, about sixteen in each row, is placed in the centre of each of the two columns of plates (fig. 5 *f*) ; and numerous smaller tubercles, degenerating into granules, occupy the rest of their surface (fig. 5 *f*) ; a second row of tubercles extends from the base to the circumference, where it terminates (fig. 5 *c*, *d*) ; the tubercles at the base of the inter-ambulacra are about the size of those occupying the same region in the inter-ambulacra ; there are twelve of these larger tubercles in each area, so that the base (fig. 5 *c*) has a much more granulated appearance than the upper surface of the test (fig. 5 *b*) ; as the median sulcus in the centre of the inter-ambulacra is sharply defined, and the poriferous zones are much sunk, the surface of the test is thereby nearly equally divided into fifteen lobes.

The poriferous zones lie in considerable depressions (fig. *b*, *d*) ; the pores are very indistinct, and arranged in oblique trigeminal ranks ; between each rank a small tubercle is developed, which adds to the granulated aspect of this region, and renders the situation of the pores still more difficult to trace (fig. 5 *f*).

The apical disc is small and prominent (fig. 5 *a*, *b*), the genital plates are nearly of the same size (fig. 5 *e*), the spongy madreporiform body is small, and the oviductal holes are pierced near the margin ; the ocular plates are small and heart-shaped, and the eye-holes are distinctly marginal ; the vent is small, and transversely oblong.

The base is flat (fig. 5 *d*), and remarkable for the much greater size of the tubercles in this region than on the upper surface ; the mouth opening is one half the diameter of the test, and the peristome is divided by feeble notches into ten unequal lobes (fig. 5 *c*.)

*Affinities and differences.*—In its general *facies*, this species resembles *Polycyphus Normannus*, but is readily distinguished from it by the marginal tubercles on the ambulacra, the two central rows of larger tubercles on the inter-ambulacra, and the smaller tubercles crowded around their base (fig. 5 *f*) ; by the row of tubercles between the trigeminal ranks of pores, the comparatively small number of tubercles in the inter-ambulacra, and the greater size of the central rows. The tubercles at the base are likewise much larger in *Polycyphus Deslongchampsii*.

*Locality and Stratigraphical position.*—I collected this urchin in the Pea-grit at Crickley Hill, with *Diadema depressum* and *Acrosalenia Lycettii*. Mr. Gibbs, of the Geological Survey, found a few specimens in the same rock and locality.

I have dedicated this species to Professor Deslongchamps, of Caen, to whom palæontologists are indebted for many valuable memoirs on the Oolitic fauna, published in the 'Mémoires de la Société Linnéenne de Normandie.'

# NOTES

ON

## Foreign Jurassic species of the genus POLYCYPHUS, nearly allied to British forms, but which have not yet been found in the English Oolites.

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Polycyphus stellatus, *Agassiz*. Catalogue raisonné, Annal. Sc. Nat., tome vi, 3$^{me}$ série, p. 361.

It closely resembles *P. Normannus*, but has fewer tubercles in the inter-ambulacral areas. The type specimen, sent me by M. Michelin, appears to be only a variety of that species.

*Formation.*—Great Oolite of Ranville, Calvados.

*Collections.*—MM. Deslongchamps and Michelin: rare. My cabinet.

Polycyphus corallinus, *Cotteau*. Études sur les Échinides, pl. 21, figs. 1—7.

A large, fine species, hemispherical above, and flat below; the narrow ambulacra, with two very regular rows of marginal tubercles, and a third row in the middle; the inter-ambulacra large, with a naked median depression; ten rows of tubercles at the equator, diminishing to two above, the horizontal rows slightly inclined. The prominence and regularity of the ambulacral tubercles forms a distinctive character of this beautiful species.

*Formation.*—Jura moyen " (Calcaire à chailles) des environs de Druyes: cette espèce est fort rare." *Cotteau.*

*Collection.*—M. Cotteau.

POLYCYPHUS DISTINCTUS, *Agassiz.* Syn. *Echinus distinctus,* Agassiz. Cat. raisonné, An. Sc. Nat., tome vi, 3me serie, p. 366.

"A very large depressed species; inter-ambulacra with from ten to twelve rows of tubercles; ambulacra with four rows of tubercles, the two internal rows much more irregular than the external.

"*Formation.*—Corallien d'Angoulin près la Rochelle.

"*Collection.*—M. d'Orbigny: rare." *Desor.*

*Genus*—STOMECHINUS,* *Desor.* 1854.

M. Desor has separated from the genus *Echinus* all those urchins which have a large mouth opening, with the peristome nearly pentagonal, through the great development of the ambulacral, and the rudimentary size of the inter-ambulacral lobes; and which have two wide, deep notches at each of the five angles of the pentagon.

This new genus or section of the ECHINIDÆ is composed of urchins of moderate size, having a hemispherical, globular, or conoidal test, which is sometimes more or less depressed in different species.

The ambulacral areas are about one third the width of the inter-ambulacral, having two marginal rows of small tubercles, from twenty to thirty in each row, and sometimes two additional internal rows, in general smaller than those of the other segments.

The inter-ambulacral areas have two principal rows of tubercles in the centre of the plates, and several secondary rows, at their sides, often as large as the principal ones; the miliary zone is sometimes broad and granular, or narrow, depressed, and more or less naked.

The apical disc is small, the genital plates are nearly equal-sized, and the spongy madreporiform body is large and prominent on the surface of the right anterior genital plate.

The mouth opening is large, the peristome is deeply notched at the base of the inter-ambulacral areas; the pairs of notches approach each other so close, that they leave only a small triangular lobe between them; the length of the ambulacral lobes is such, that it produces a pentagonal-shaped mouth; the notches have the margin reflected at each of the angles.

The poriferous zones are moderately wide, and the pores are arranged in triple oblique pairs, as in the genus *Echinus*.

The spines are small, short, stout, and blunt pointed; their surface is covered with well-marked longitudinal lines.

This genus is extinct, and appears to be limited to the Oolitic formations. The species are found in the Inferior Oolite, Great Oolite, Cornbrash, Coral Rag, Kimmeridge Clay, and Portland Oolite; they, however, attained their greatest development in the lower division of the Oolites.

* From στόμα, mouth.

### A. *Species from the Inferior Oolite.*

STOMECHINUS GERMINANS, *Phillips.* Pl. XIV, fig. 1, *a*, *b*, *c*, *d*.

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| ECHINUS GERMINANS. | Phillips, Geology of Yorkshire, pl. 3, fig. 15, p. 127. |
| — — | Murchison, Geology of Cheltenham, 2d edit., p. 73. |
| — — | Morris, Catalogue of British Fossils, p. 52. |
| — PERLATUS, var. GERMINANS. | Wright, Annals and Magazine of Natural History, 2d series, vol. viii, pl. 13, fig. 1 *a*—*d*, p. 274. |
| — DIADEMATA. | M'Coy, Annals and Magazine of Natural History, 2d series, vol. ii, p. 410. |
| — PERLATUS. | Forbes, in Morris's Catalogue of Brit. Foss., 2d edit., p. 79. |
| — — | Salter, Memoirs of the Geological Survey, Decade V, pl. 4. |
| STOMECHINUS GERMINANS. | Desor, Synopsis des Échinides Fossiles, p. 126. |
| — SUB-CONOIDEUS. | Desor, Synopsis des Échinides Fossiles, p. 125. |

Test high, conoidal; marginal fold acute, circumference sub-pentagonal; ambulacral areas with two rows of primary tubercles, thirty-four in each row; poriferous zones wide, the trigeminal ranks lie very obliquely across the zone; inter-ambulacral areas with one central row of primary tubercles in the middle, two rows of secondaries on the zonal, and one on the centro-sutural side of each column of plates; miliary zone wide and finely granulated, with a naked median depression in the upper half; apical disc small, excentral; genital plates very narrow, vent transversely oblong, base concave; mouth opening very large; peristome pentagonal, with bifid-notched angles, the ten notches wide and deep.

*Dimensions.*—Height, one inch and a half; transverse diameter, two inches.

*Description.*—Since the publication of my 'Memoir on the Cidaridæ of the Oolites,' in which this urchin was first described, I have obtained specimens of *Echinus perlatus*, Desmarest, which has enabled me to make a critical comparison between our specimens and the species to which it was referred, and I have thereby been enabled to correct errors in my previous determination.

The test of *Stomechinus germinans*, especially in adult specimens, is always high and conoidal (fig. 1 *a*); the sides rise abruptly from an acute marginal angle; the prominence of the ambulacra, and the median depression in the inter-ambulacra, impart a lobed appearance to its upper surface.

The ambulacral areas are one third the width of the inter-ambulacral (fig. 1 *a*, *c*); they are very uniform in breadth throughout, and from being convex and prominent, give a sub-pentagonal form to the circumference; they have two rows of tubercles on their margins, from thirty to thirty-four in each row, a smaller tubercle often alternating

with a larger one (fig. 1 *c*); the tubercles of the ambulacra are smaller than those of the inter-ambulacra; they are raised on small bosses, and surrounded by depressed, ring-shaped areolas (fig. 1 *c*), which are bounded on one side by the poriferous zones, and on the other by a row of small lateral granules; between the two rows of granules there is a naked space (fig. 1 *c*), in which the suture is distinctly seen; towards the base of the area this space is filled with other rows of granules, and from four to six large tubercles, which extend round the angle to the base (fig. 1 *b*), where the marginal tubercles are disposed with great regularity, surrounded on each side by trigeminal ranks of pores, which lie at angles of 20° across the wide zonal space (fig. 1 *d*).

The poriferous zones are of a uniform width on the sides; they are slightly contracted at the angle, and again expand at the base; the trigeminal ranks of pores are disposed very obliquely across the zones, at angles of from 30° to 40°; there are three small granules between each rank (fig. 1 *c*), and each pair of pores is surrounded by an oval elevation of the test; the pores of each pair are placed obliquely upwards, and there are about five trigeminal ranks opposite every two large plates, which, estimating twenty-eight plates in a column, gives about seventy triple oblique pairs of pores in each zone.

The inter-ambulacral areas are three times the width of the ambulacral; they are composed of long, narrow, pentagonal plates, of which there are twenty-eight in each column of an adult shell; each area has two rows of primary tubercles in the centre of the plates, which extend from the peristome to the apical disc (fig. 1 *a*); between this row and the poriferous zones there are two rows of secondary tubercles, which become rudimentary half way up the sides; between the primary row and the centro-suture there is another short row of six or seven secondaries (fig. 1 *a*, *c*); the tubercles are raised on small bosses, which are surrounded by depressed areolas, and the granules of the miliary zone form complete circles around them.

On the upper half of the area there is a well-marked median depression, which divides it into halves; the depression is naked, but the rest of the wide inter-tubercular space is covered with numerous granules (fig. 1 *a*).

The marginal fold in this species forms an acute angle; the base is concave, and crowded with large tubercles, the secondaries being as large as the primary rows in this region of the test (fig. 1 *b*).

The mouth opening is very large, nearly one half the diameter of the base; the peristome is pentagonal, with two wide and deeply incised notches at each angle, opposite the base of the inter-ambulacral areas (fig. 1 *b*); between these the short lobe is rounded, and the margins of the large ambulacral lobes form double curved lines (fig. 1 *b*, *d*).

The apical disc is small and excentral; it is placed backwards, and projects into the single inter-ambulacrum; the genital plates are very narrow, the anterior pair being larger than the posterior pair; the right antero-lateral plate, with the prominent spongy madreporiform body, is the largest, and the posterior single plate the smallest; the oviductal holes are pierced near the apex; the ocular plates are small and heart-shaped,

and the minute eye-holes appear like slits near the border; the vent is transversely oblong, or has sometimes an irregular form (Pl. XIV, fig. 1 *a*).

The spines are small, delicate, and subulate, but are very seldom found in connection with the tubercles. I have seen them twice when cleaning specimens, but unfortunately they have fallen off in drying.

*Affinities and differences.*—This is the true *Echinus germinans*, Phillips. Through the kindness of Mr. Reed, of York, I possess two specimens of the type urchin, collected by him at Whitwell, which I have critically compared with our specimens, and found them to be identical. This species is certainly distinct from *Echinus perlatus*, Desmarest, which has smaller and more numerous tubercles in the inter-ambulacra, narrower poriferous zones, and wider ambulacra, than *Stomechinus germinans*.

It differs from *Stomechinus intermedius* (Pl. XIV, fig. 2), which is considered by some to be a mere variety of *St. germinans*, in having a more elevated and conoidal test, larger tubercles, narrower and more prominent ambulacra, the apical disc more excentral, the marginal angle more acute, the mouth opening larger, and the notches wider, with deeper incisions; but the two forms are unquestionably most nearly allied, and it is only when placed side by side, and closely compared, that the differences become evident.

It differs from *Stomechinus bigranularis* (Pl. XIV, fig. 3) in all the structural details already referred to, in the comparison with *St. intermedius;* but in addition to these, the globose test, with its inflated sides and convex base, so characteristic of *St. bigranularis*, added to the small mouth opening which this species possesses, enables us to distinguish it readily from *St. germinans;* as I shall have to return to these affinities and differences when treating of both forms, I reserve further details until the respective species are the subject of our special study.

*Locality and Stratigraphical position.*—I have collected this species in the Pea-grit of Leckhampton, Birdlip, and Crickley Hills, and it is found in the freestone beds of the Inferior Oolite at Nailsworth and Wallsquarry, Gloucestershire. In Yorkshire it is collected from the freestone beds of the Inferior Oolite at Whitwell, near Castle Howard. These beds have been considered to be Great Oolite, but I am of opinion they are true Inferior Oolite, as Mr. Reed obtained, at Whitwell, with *Stomechinus germinans*, *Gervillia Hartmanni*, Münst., the large quadrate Inferior Oolite variety of *Trigonia costata*, Sow., and other well-known Inferior Oolite shells. It is by mistake that this urchin has been said to be found in the Coralline Oolite at Malton, as I shall endeavour to show in the history of the species. The *Echinus diadematа*, M'Coy is a small Whitwell specimen of *St. germinans*. From the facts before me, I conclude that this is a true Inferior Oolite species, and the first and most typical of the genus to which it is referred.

*History.*—This urchin was first figured by Professor John Phillips, in his 'Geology of

the Yorkshire Coast,' in his plate of Coralline Oolite fossils, and was said to be collected from the Great Oolite at Whitwell, and the Coralline Oolite of Malton and Scarborough. The statement that it occurred in the Coral Rag led both Professor Forbes and myself to suppose that it might be a variety of *Echinus perlatus*, and under this impression it was described as such by us both. Since the publication of my Memoir, I have visited most of the typical collections of Yorkshire fossils, with the view of determining some doubtful points relative to the stratigraphical position of certain species, and from this examination I am satisfied that *Stomechinus germinans* has not been found out of the Inferior (Great?) Oolite of Whitwell and other Inferior Oolite localities. The statement that it came from Malton was first made by a collector who obtained the specimens at Whitwell, and *sold them as Malton fossils.* Mr. Reed, of York, who was acquainted with the facts, writes me as follows: "There cannot, I think, be a doubt as to the correctness of your previously strongly expressed opinion regarding the distribution of *Echinus germinans*, Phil., and *Clypeus semisulcatus*, Phil., in the Oolitic beds, very *exclusively in the lower series*, and not both in the latter and Coralline Oolite, as stated by Professor Phillips in his work on the 'Geology of Yorkshire.' From long experience I am decidedly of opinion that neither species have ever been found in the Coralline Oolite at Malton or the neighbourhood. The error originated from the fact of a local collector, named Larcum, having sold the specimens which he obtained at the different quarries, and from different strata, six or eight miles round Malton, as Malton fossils. He was in the habit of procuring his specimens from the Great Oolite of Whitwell and Weston, also from some quarries at or near Coneysthorpe, most probably Inferior Oolite, and from the Calcareous grit at Appleton, as well as from the Coralline Oolite of Malton. I may also remark that he was wholly ignorant of geology, and I know, from personal experience, that he was unacquainted with the distribution and names of the Oolitic beds in the neighbourhood, having for many years obtained fossils from him. He was, I believe, the exclusive dealer in Malton for more than half a century."

Professor M'Coy described* a specimen of this species as *Echinus diadematus*, from the Coralline Oolite of Malton. Through the kindness of Professor Sedgwick I have been enabled to examine this specimen, belonging to the Cambridge Museum, and have compared it with my Whitwell specimens, and there cannot be a doubt of their identity.

This species was first figured by Professor Phillips, in the 'Geology of Yorkshire,' as *Echinus germinans.* It was afterwards figured and described, for the first time, in my 'Memoir on the Cidaridæ of the Oolites,' as *Echinus perlatus*, var. *germinans.* Professor Forbes, in Morris's 'Catalogue,' and in lettering Pl. IV, Decade V, of the 'Memoirs of the Geological Survey,' retained the same name. Mr. Salter, in his elaborate article on this urchin, in the same work, describes it as *Echinus perlatus.*

* 'Annals and Magazine of Natural History,' 2d series, vol. ii, p. 410.

STOMECHINUS INTERMEDIUS, *Agassiz*. Pl. XIV, fig. 2 *a, b, c, d.*

ECHINUS INTERMEDIUS. Agassiz, Catalogus systematicus Ectyporum Echinodermatum, p. 12.

— GRANULARIS. Wright, Annals and Magazine of Natural History, 2d series, vol. viii, p. 277.

Test hemispherical, depressed, inflated at the sides, nearly circular at the circumference, sometimes inclining to a sub-pentagonal form; ambulacral areas with two rows of small tubercles on the margins, and a miliary zone between; poriferous zones wide; trigeminal ranks very oblique; inter-ambulacral areas with two entire primary, and four short secondary rows of small tubercles; miliary zone very wide, and covered with small granules; apical disc slightly excentral, of moderate size, genital plates fully developed; mouth opening large; peristome pentagonal, with two small notches at each angle; inter-ambulacral areas slightly depressed at the centro-suture.

*Dimensions.*—Height, one inch and one fifth; transverse diameter, one inch and nine tenths.

*Description.*—Through the kindness of Professor Deslongchamps, I possess a type specimen of *Echinus intermedius* from the Great Oolite of Ranville, and which fossil was determined by M. Agassiz. This specimen has enabled me to distinguish the urchin mentioned in the 'Catalogue raisonné,' and entered as var. *major* of *Echinus bigranularis*, Lamarck, in that memoir.

It is certainly very difficult to describe the nice distinctions between the first three species, beautifully and truthfully drawn in Pl. XIV, as they graduate into each other so insensibly, that it is almost impossible to seize their distinctive characters; so much so, that at one time I considered them varieties of one species; having, however, examined a great many specimens of these Echini, I am satisfied that if varieties, they are permanent ones, and as such require a separate description. Their structural characters, however, are sufficiently marked to justify their separation into distinct species.

The test of *Stomechinus intermedius* is hemispherical, but rather depressed above; the sides are a little inflated, the marginal angle is obtuse, and the base is flat (fig. 2 *c*); the ambulacral areas are one third the width of the inter-ambulacral; they have two marginal rows of small tubercles, about thirty in each row, arranged with regularity on the margins of the areas (fig. 2 *a, d*); these tubercles have small bosses, and narrow areolas, which are encircled by minute granules; there are two rows of granules between the tubercles and the suture (fig. 2 *d*), which extend through the entire length of the area.

The poriferous zones are wide, the trigeminal ranks incline at about 40°; three small tubercles are placed between each rank (fig. 2 *d*), and there are two ranks opposite each

inter-ambulacral plate; the zones are slightly contracted at the margin, and expand again at the base.

The inter-ambulacral areas are three times as wide as the ambulacral (fig. 2 *c*); each column consists of about twenty-five elongated, pentagonal plates (fig. 2 *d*), and a median depression divides the area from the margin to the disc into two lobes; there are two rows of small primary tubercles in the centre of the plates (fig. 2 *c*, *d*), which extend from the peristome to the disc, and two short rows of secondaries on their zonal sides, which disappear a little way above the margin; within the primary rows at the base are six or seven more; from the circumference to the disc there is a wide miliary zone (fig. 2 *a*, *c*), which is filled with small tubercles and minute granules, arranged, however, with considerable regularity on the plates (fig. 2 *d*), and extending even over the median depression, which, when taken in connection with the smallness of the tubercles, about the same size in both areas, imparts a peculiar granular appearance to the test of this species.

The base is flat, and the tubercles, as usual, are larger in this region; the mouth opening is eight tenths of an inch, the diameter of the test being one inch and nine tenths; the peristome is pentagonal, with two notches at each angle, and a small lobe between, the large ambulacral lobes forming the sides of the pentagon (fig. 2 *b*).

The apical disc is well developed, and slightly excentral (fig. 2 *c*); the genital plates (fig. 2 *a*, *e*), are elongated, and perforated near their outer third, the right antero-lateral being much the largest, and supporting a prominent madreporiform body (fig. 2 *e*); the ocular plates are small pentagons, with slit-like eye-holes; the disc is much more developed in this species than it is either in *Stomechinus germinans* or *bigranularis*.

*Affinities and differences.*—This urchin is distinguished from *Stomechinus germinans* by the following characters: The test is more regular in its form, less elevated and rounder, and never assumes a conoidal figure; the tubercles are much smaller, and equal-sized; the small tubercles and granules on the miliary zone are larger, and have a more regular arrangement, which, with the smallness of the primary tubercles, gives the test a more granular *facies*. The marginal angle is more obtuse, and the sides are inflated; the apical disc is larger, and its elements are more developed; the mouth opening is proportionally smaller, and the notches are neither so wide nor so deeply incised. *Stomechinus intermedius* is considered by MM. Agassiz and Desor to be a variety of *St. bigranularis;* but, between the structure of the apical disc, the arrangement of the trigeminal ranks in the poriferous zones, and in the size of the mouth opening, we find characters sufficient to show that the affinity between *St. germinans* and *St. intermedius* is greater than between *St. intermedius* and *St. bigranularis*.

*Locality and Stratigraphical position.*—I have collected this species in the upper rag-stones of Shurdington, Rodborough, and Dundry Hills, where it is extremely rare. The Dundry specimen I formerly described under the name of *Echinus granularis*. I found a

beautiful specimen in the Trigonia grit of Hampen, Gloucestershire, with *Pedina rotata*, *Holectypus depressus*, and *Collyrites hemisphæricus*. The Rev. A. W. Griesbach collected one specimen in the Cornbrash, at Rushden, Northamptonshire; and Mr. Buy obtained another from the Cornbrash, near Sutton, Wilts.

STOMECHINUS BIGRANULARIS, *Lamarck*. Pl. XIV, fig. 3 *a*, *b*, *c*, *d*, *e*.

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|---|---|
| ECHINUS BIGRANULARIS. | Lamarck, Animaux sans Vertèbres, tome iii, p. 50. |
| — — | Agassiz and Desor, Catalogue raisonné des Échinides, Annal. des Sciences Naturelles, 3me série, tome vi, p. 365. |
| — SERIALIS. | Wright, Annals and Magazine of Natural History, 2d series, vol. viii, p. 276, pl. 13, fig. 2. |
| — — | Forbes, in Morris's Catalogue of British Fossils, 2d edit., p. 79. |
| — PERLATUS, var. FORBESII. | Salter, Memoirs of the Geological Survey, Decade V, pl. 4, fig. 6. |
| STOMECHINUS BIGRANULARIS. | Desor, Synopsis des Échinides Fossiles, p. 125, tab. xviii, fig. 5—7. |

Test hemispherical, depressed; sides inflated, circumference more or less sub-pentagonal; ambulacral areas with two rows of small tubercles on the margins, placed wide apart, twenty-six in each row, and a very fine granulation between; poriferous zones narrow, trigeminal ranks not very oblique, becoming nearly parallel on the upper and under surfaces; inter-ambulacral areas with two rows of primary tubercles, twenty in each row, and two short rows of secondaries, which disappear at the circumference; miliary zone wide, and uniformly covered with small, equal-sized granules; mouth opening small; peristome pentagonal, with ten shallow, obtuse notches; apical disc large, excentral; all the genital plates, with the exception of the right antero-lateral, small; vent large, and encircled by a moniliform line of small granules.

*Dimensions.*—Specimen A, fig. 3 *a*. Height, one inch and one fifth; transverse diameter, one inch and seven tenths.

„ B, fig. 3 *b*. Height, one inch and seven twentieths; transverse diameter, two inches.

*Description.*—This species is supposed to be *Echinus antiquus*, Defrance MSS., and *Echinus bigranularis*, Lamarck, although this is not quite clear. M. Desor says—"I have been for a long time in doubt as to the identity of this species, which was so much more difficult to define, as, among the originals in the Paris Museum, ticketed by the hand of Lamarck, there are found many species. After much hesitation, I propose to

restrict the name *bigranularis* to the Oolitic species, so well figured by M. Wright under the name *serialis*, and afterwards by M. Forbes."* I am the more disposed to accept this determination, as I have a beautiful specimen of this species from the Ferrugenous or Inferior Oolite of Croisilles, Calvados, kindly sent me by M. Michelin as *Echinus bigranularis*, Agassiz, and determined by him, which exactly corresponds with our English specimens.

I have been fortunate in obtaining a fine series of this urchin, which has enabled me to study the variations it presents at different periods of growth; with the exception of some forms being more globular, others more pentagonal, all its essential characters are extremely persistent in my specimens.

The test is sometimes globular, but in general hemisperical and depressed; the circumference is occasionally round, but oftener sub-pentagonal, and varies in size from one to two inches in diameter. The specimen figured is an extremely pentagonal variety, and was selected because the tubercles and sculpture of the test were finely preserved (fig. 3 *a*, *c*).

The ambulacral areas are narrow, and nearly of a uniform width throughout; they have two rows of small tubercles, placed wide apart on the margins, of which there are twenty-six in each row (fig. *a*, *c*); every alternate plate in the column carries a tubercle, which alternates with a plate covered with two rows of small granules (fig. 3 *d*); at the base the tubercles are larger (fig. 3 *b*), and in the middle two rows of small granules separate the marginal tubercles (fig. 3 *d*).

The poriferous zones are narrower than in *St. germinans* and *St. intermedius;* the trigeminal ranks incline at angles of from 55° to 60°; they become more sub-parallel on the upper part of the zones, and towards the base; there is one small tubercle at the angle between each file (fig. 3 *d*) of pores, and there are five trigeminal ranks opposite two tubercular plates.

The inter-ambulacral areas are three and a half times as wide as the ambulacral (fig. 3, *a*, *c*); the plates are broader than in the preceding species; and consequently there are only from twenty to twenty-two plates in a column. There are two rows of primary tubercles, which are placed nearer the poriferous rows than the centro-suture (fig. 3 *c*); they are a little larger than the ambulacral tubercles, and nearly of the same size from the circumference upwards. A row of smaller secondary tubercles, about twelve in number, occupies their zonal side, and extends half way up the test (fig. 3 *c*). The tubercles are raised on bosses (fig. 3 *d*), surrounded by narrow, ring-like areolas, a series of small granules encircle the base, and the remaining surface of the plates is dotted over with numerous small equal-sized granules (fig. 3 *d*). There is a very slight median depression, from the upper part of which the small granules are absent (fig. 3 *a*). At the base of the area six larger tubercles are disposed within the primary rows (fig. 3 *b*).

* 'Synopsis des Échinides Fossiles,' p. 125.

The base is flat, and, as all the tubercles are of an equal size, this region of the test presents a remarkable tuberculous character (fig. 3 *b*), when compared with its smooth upper surface (fig. 3 *a*); the mouth opening is much smaller than in *St. germinans* and *St. intermedius*; thus, in fig. 3 *b*, the diameter of the test is nearly two inches, whilst the width of the mouth is seven tenths of an inch; in fact, the smallness of this opening is one the most important diagnostic characters of the species, and becomes very evident when we compare fig. 2 *b* and fig. 1 *a*, with fig. 3 *b*; this comparative smallness of the mouth is a persistent character in all the specimens I have examined, the peristome is pentagonal, with two obtuse notches at each angle.

The apical disc is of moderate size and slightly excentral, projecting backwards into the single inter-ambulacrum (fig. 3 *c*); the anterior pair of genital plates are larger than the posterior pair. The right plate, with the madreporiform body, is the largest, and the posterior single plate the smallest (fig. 3 *a*, *e*). On the surface of each of these plates, the anterior right plate excepted, there are six or seven small tubercles arranged, which collectively form a moniliform ring about the margin of the vent (fig. 3 *e*), which is extremely large in this species, and projects slightly towards the left side of the body; the ocular plates are small, and the eye-holes like oblong slits (fig. 3 *e*).

*Affinities and differences.*—In the general form and physiognomy of the test, this species resembles *Stomechinus intermedius;* it is distinguished from that species, however, by having fewer ambulacral and inter-ambulacral tubercles, the poriferous zones narrower, the trigeminal ranks of pores more upright, and the mouth opening much smaller. The apical disc is larger, the anal opening much wider, with a circle of granules around its margin; on the miliary zones the granules are likewise smaller and more numerous. The same group of characters serve to distinguish it still more distinctly from *St. germinans.*

M. Desor and M. Agassiz consider *St. intermedius* as a variety of *St. bigranularis;* but from this opinion I must beg to differ, because, although *St. germinans* and *St. intermedius* may possibly be varieties of one species, still assuredly *St. bigranularis* is distinct from both; the smallness of the mouth opening, the structure of the apical disc, and the greater breadth of the inter-ambulacral plates, in my judgment, justify the distinction.

*Locality and Stratigraphical position.*—I have collected this species only from the Upper Ragstones of the Inferior Oolite near Bridport, in Dorsetshire, associated with *Holectypus hemisphæricus,* Desor; *Clypeus altus,* M'Coy; *Ammonites Parkinsoni,* Sow.; and *Terebratula sphæroidalis,* Sow.

The specimen I figured in the 'Annals of Natural History' as *Echinus serialis* was said to have been collected from Dundry Hill, but I find this was a mistake, as it turns out to

be a Dorsetshire fossil. I have never seen *St. bigranularis* in the Inferior Oolite of Gloucestershire. In this county it is represented by *St. intermedius*.

The only authentic foreign locality that I am acquainted with is Croisilles, Calvados, where it occurs in a brown ferruginous Inferior Oolite, containing numerous large grains of the hydrate of iron, the "calc. à polypiers de Croisilles," Michelin.

*History.*—First figured in my 'Memoir on the Cidaridæ of the Oolites' as *Echinus serialis*, afterwards by Professor Forbes in the fifth decade, pl. 4, fig. 6, of the 'Memoirs of the Geological Survey;' where it was well described by Mr. Salter as *Echinus perlatus*, var. *Forbesii*.

B. *Species from the Great Oolite*—11^e^ *Étage, Bathonien*, d'Orbigny.

Stomechinus microcyphus, *Wright*, nov. sp. Pl. XV, fig. 1 *a*, *b*.

Test circular, hemispherical, with a flat base; ambulacral areas with four rows of tubercles, diminishing to two on the upper surface; inter-ambulacral areas with ten rows of tubercles at the equator, irregularly disposed on the plates, and a median depression in the line of the centro-suture; poriferous zones wide, the pores in oblique ranks of threes, and between each file two small granules regularly disposed.

*Dimensions.*—Height, six tenths of an inch; transverse diameter, nearly one inch.

*Description.*—The modern generic divisions of the family Echinidæ often repose upon characters which undergo many phases of development in the different species; and thus it sometimes happens, as in the urchin now under consideration, some of the species approach, in their ensemble, nearer to aberrant forms of an allied genus than to the one to which they are referred.

This form certainly very much resembles a large *Polycyphus Normannus*, Desor; although the state of conservation of the test, and the concealment of the base by adherent rock, prevents that amount of examination so necessary for a critical diagnosis; still, however, the specimen exhibits such a group of characters, that I have placed it in the genus *Stomechinus* for the following reasons: 1st, The size of the body; 2d, the thickness of the test; 3d, the irregular arrangement of the tubercles on the inter-ambulacral plates; and 4th, the absence of a median depression in the inter-ambulacra.

The ambulacral areas (fig. 1 *b*) have four rows of tubercles at the equator, two marginal rows placed on the extreme borders of the area, and two inner rows near the sutural line; the tubercles all alternate with each other (fig. 1 *b*), and the two inner rows disappear at the upper surface.

The poriferous zones are wide; the pairs of pores are disposed in oblique ranks of threes, rather widely asunder (fig. 1 *b*), and between each rank two small tubercles are developed, which separate them from each other throughout the zones (fig. 1 *b*), so that there is only one trigeminal rank of pores opposite each large inter-ambulacral plate.

The inter-ambulacral segments are twice the width of the ambulacral; the centro-suture is very distinctly marked, but there is no median depression, and the division of the test into fifteen lobes, so characteristic of *Polycyphus*, is not seen in this form; each of the large plates in general supports four or five tubercles, which are rather irregularly disposed on its surface (fig. 1 *b*); they have narrow, ring-like areolas around their base, encircled by rows of small granules (fig. 1 *b*), invisible to the naked eye, and only seen with a lens; the inter-ambulacra have therefore ten rows of tubercles at the equator; the third tubercle from the poriferous zones represents the principal row, which is continuous from the base to the disc; but the other lateral rows disappear at different points between the circumference and the vertex.

The apical disc is unfortunately absent, and the base is adherent to a hard shelly fragment of the Great Oolite limestone, which cannot be removed without, at the same time, detaching the shell. In this remarkable formation, the Oolitic grains are indented into the plates of the test of the Echinodermata, as well as into the shells of the Mollusca; and unless the specimen separates readily from the matrix, it is almost hopeless to expect to remove it without so much injury to the sculpture as will render its determination doubtful, or even impossible. For this reason I have been unable to expose the base of this beautiful rare form.

*Affinities and differences.*—The nearest affinities of this species is with *Polycyphus Normannus*, Desor; but it has a much thicker test, the inter-ambulacral tubercles are proportionately smaller and more irregularly disposed, and they have circles of granules around their areolas; the segments are not divided into lobes by median depressions; the poriferous zones are wide and only slightly depressed, and the trigeminal ranks of pores are separated by small tubercles: all these diagnostic characters show how distinct *Stomechinus microcyphus* is from *Polycyphus Normannus*, when a critical comparison is made between these two urchins, which are often found in the same bed. I know of no other form for which our species could be mistaken.

*Locality and Stratigraphical position.*—This beautiful urchin is one of the many exquisite fossils collected by my friend Mr. Lycett, from the Great Oolite of Minchinhampton Common. It occurs in the shelly beds of limestone at the large quarry, and is the only specimen found by him, after many years' diligent search, in his favorite localities.

I have one small specimen of the same urchin, collected from the Great Oolite of

Ranville, Calvados, by M. Tesson, in which the apical disc is preserved. It is small and prominent; the genital plates are nearly equal-sized, the right anterior plate is the largest, and the spongy madreporiform body occupies all the surface of that plate; the oculars are small, and deeply indented where they receive the apex of the ambulacra; the genital holes are perforated about the outer third of the plates; the vent is oblong, and its long diameter lies obliquely across the test. It is doubtless a rare urchin in France, as none of the systematic authors make mention of it; or it may be that it has hitherto been confounded with *Polycyphus Normannus*.

### C. *Species from the Coral Rag*—14$^{e}$ *Étage Corallien*, d'Orbigny.

STOMECHINUS GYRATUS, *Agassiz*. Pl. XIV, fig. 4 *a*, *b*, *c*, *d*, *e*.

| | |
|---|---|
| ECHINUS GYRATUS. | Agassiz, Échinoderm. Fossiles de la Suisse, part ii, p. 87, pl. 23, figs. 34—46. |
| — PETALLATUS. | M'Coy, Annals and Magazine of Natural History, 2d series, vol. ii, p. 409. |
| — GYRATUS. | Agassiz and Desor, Catalogue raisonné des Échinides, Annales des Sciences Naturelles, 3$^{me}$ série, tom. vi, p. 366. |
| — GYRATUS. | Wright, Annals and Magazine of Natural History, 2d series, vol. ix, p. 85. |
| — — | Forbes in Morris's Catalogue of British Fossils, 2d edit., p. 79. |
| — — | Salter, Memoirs of the Geological Survey, Decade V. Notes on Echinus, p. 8. |
| STOMECHINUS GYRATUS. | Desor, Synopsis des Échinides Fossiles, p. 126. |

Test hemispherical, more or less elevated, inflated at the sides, round at the circumference; sides divided by depressions into fifteen unequal, slightly convex lobes; ambulacral areas half the width of the inter-ambulacral, with two complete rows of marginal tubercles extending from the peristome to the disc, and two incomplete rows of central tubercles occupying two thirds of the sides; inter-ambulacral areas divided into lobes by naked median depressions, which extend from the disc to the circumference; each lobe has one complete central row, and four incomplete lateral rows of secondary tubercles; apical disc central; vent small; mouth opening wide; peristome pentagonal.

*Dimensions.*—Height, one inch; transverse diameter one inch and four tenths.

*Description.*—This beautiful urchin was figured, with details, by M. Agassiz, in his 'Échinodermes Fossiles de la Suisse;' its specific characters are so well marked that it can scarcely be mistaken for any other species. The test is hemispherical, more or less

elevated, and very regularly formed; its surface is divided into fifteen nearly equal-sized lobes grouped in five divisions, with three lobes in each, of which the ambulacra form the centre, and the half of the adjoining inter-ambulacra the two lateral lobes (fig. 4 *a*).

The distinctive character of this species consists in the wide, naked median depression in the centre of the inter-ambulacral areas, which extends from the circumference to the apical disc, and is throughout entirely destitute of granules or any other sculpture (fig. 4 *a*); near the circumference, however, small tubercles occupy the space, and at this point there are twelve tubercles, in a horizontal row, in a single inter-ambulacral area; each area is thus divided into two convex lobes by a median sulcus; in each lobe there is one complete principal row of twenty-five tubercles, which extends from the peristome to the disc, and two incomplete rows on each side of the principal row, with from twelve to eighteen tubercles in each, which disappear on the sides; besides these at the widest part of the area, a few small additional tubercles are introduced (fig. 4 *c*, *d*); the bosses are small, and closely surrounded by circles of granules (fig. 4 *d*); the tubercles are large and prominent, and nearly all of the same size, which gives the surface of this urchin very much the appearance of a large *Polycyphus*.

The ambulacral areas are nearly half as wide as the inter-ambulacral; they are furnished with two complete rows of tubercles disposed on the margins of the area, and two incomplete rows which occupy the central parts of the sides (fig. 4 *d*); the tubercles have small bosses, around which granules are disposed in circles, and similar moniliform granular rings surround the larger tubercles of the incomplete rows (fig. 4 *d*).

The tubercles of both areas are large, prominent, and highly polished; those at the base are a little larger than the tubercles on the sides; and it may be said of this species in general that the test is uniformly very granular, and forms a remarkable contrast to that of *Stomechinus bigranularis* (fig. 3 *a*).

The poriferous zones are narrow, the trigeminal ranks form angles of about 65°, which become nearly sub-parallel in the upper part of the zone and at the base (fig. 4 *b*, *c*); two small granules are dotted between each file of pores.

The apical disc is small and central (fig. 4 *a*); the genital plates are nearly equal-sized, with the exception of the right antero-lateral, which is the largest, and supports a fine spongy madreporiform body (fig. 4 *e*); a series of granules on the plates form a circle around the vent, which is of a moderate size. The ocular plates are small, pentagonal pieces, projecting from between the angles of the genitals; there are two holes in each plate, with a transverse slit between (fig. 4 *e*). The oviductal holes are conspicuous, and perforated near the outer third of the plate.

The mouth opening is very large, nearly one half the diameter of the test (fig. 4 *b*); the peristome is pentagonal, with two wide, obtuse notches at each angle, and a small, lip-like lobe between; the ambulacral lobes are four times as broad as the inter-ambulacral, and form the sides of the pentagon.

*Affinities and differences.*—M. Desor, by mistake, has placed *Stomechinus gyratus* as a synonym of *Stomechinus germinans*, and described the true *Stomechinus germinans* as a new species under the name *Stomechinus sub-conoideus*, a confusion which has doubtless arisen from the stratigraphical error already pointed out in the history of *St. germinans*. The following characters will show how entirely distinct *St. gyratus* is from the three closely allied forms of the Inferior Oolite. It differs from *St. germinans* in having the naked median sulcus wider and deeper, and extending further down the sides; in having four rows of equal-sized tubercles in the ambulacra, whilst *St. germinans* has only two. The secondary tubercles of the inter-ambulacral areas are as large as the principal row, and there is no miliary zone in this species; whereas, in *Stomechinus germinans*, *intermedius*, and *bigranularis*, the miliary zone is a very wide granular space. The tubercles are likewise larger and nearly of the same size in both areas. I have been able to examine *Echinus petallatus*, M'Coy, through the extreme kindness of Professor Sedgwick, and compared it with the urchin I have figured; I can, therefore, state that it is an unquestionable specimen of *Echinus gyratus*, Agass., and not in any way a distinct form, as Professor M'Coy supposed.

*Locality and Stratigraphical position.*—*Stomechinus gyratus* is rarely found in the Clay beds of the Coral Rag, near Calne, Wilts; I am not aware that it has been collected in any other locality in England. Its foreign locality is likewise limited to the "terrain à Chailles" or Corallian stage of Besançon. I have a specimen from the Coral Rag of the department of Haute Saone, France, kindly sent me by M. Michelin.

*History.*—First described by M. Agassiz in his 'Échinodermes Fossiles de la Suisse,' where it is beautifully and accurately figured. The English form was afterwards described by M'Coy as *Echinus petallatus*. It was first described in detail in my 'Memoir on the Cidaridæ of the Oolites,' and its distinction from our other Oolitic Echinidæ was therein indicated. It is probable, that Parkinson's figure, in vol. 3 of his 'Organic Remains,' described as an 'Echinite from France,' refers to this species.

STOMECHINUS NUDUS, *Wright*, nov. sp. Pl. XV, fig. 2 *a*, *b*, *c*, *d*, *e*.

Test circular, conoidal; ambulacra flat, with two regular marginal rows of tubercles, twenty-four in each row, and two inner rows which occupy the middle half of the area; poriferous zones wide; pores oblique; two small granules between each trigeminal rank; inter-ambulacra with eighteen plates in each column; equatorial plates with four or five

tubercles disposed irregularly on the surface on each plate, the number diminishing on the upper surface; tubercles surrounded by small, depressed, ring-like areolas, scarcely any granules on the surface of the plates; apical disc small, genital plates narrow, ocular plates prominent, with transverse eye-holes; base flat, inter-ambulacra forming convex lobes around the peristome.

*Dimensions.*—Height, seven tenths of an inch; transverse diameter nine tenths of an inch.

*Description.*—This small conoidal Echinite in many respects resembles *Stomechinus gyratus*, Agass., and might at first sight be supposed to be a mere variety of that form, but a closer examination proves it to be distinct; the test is circular and elevated, the sides rising suddenly from the basal angle; the ambulacral areas are flat, having two rows of tubercles regularly arranged on their margins, about twenty-four in each row, with two irregular internal rows, which occupy about the middle half of the area; the tubercles are all nearly of the same size; they have narrow, sunken areolas around their base, but scarcely any granules on the surface of the plates (fig. 2 *d*).

The poriferous zones are wide, the trigeminal ranks form angles of 40° to 50°; between each rank there are two granules, and there are three ranks opposite two tubercular plates; as there are eighteen plates in each column, there are therefore about twenty-seven trigeminal ranks in each poriferous zone.

The inter-ambulacral areas are rather more than twice the width of the ambulacral, each column contains about eighteen plates, and on each plate, at the widest part of the area, there are from four to five tubercles, so irregularly disposed that the arrangement is different on every plate (fig. 2 *d*); the tubercles are all about the same size, they are surrounded by narrow, sunken areolas; a few smaller tubercles are scattered among them, but there are no circles of granules around their base, which gives the surface of the plates a naked appearance; there is no depression in the middle of the areas, and the region of the centro-suture between the five uppermost pairs of plates is naked but not depressed; the areas become convex and prominent below.

The apical disc is small (fig. 2 *a*); the genital plates are narrow, and the anterior larger than the posterior pair; the spongy madreporiform body occupies the surface of the right anterior plate (fig. 2 *e*); the ocular plates are small, but prominent, and the eye-holes form transverse slits on their sides; the vent is oblong (fig. 2 *e*), and around its margin there are three parts of a circle of granules; the oviductal holes are large, and perforated near the apex of the plates.

The base is much covered with adhering matrix (fig. 2 *b*), so that the form of the mouth opening is nearly concealed; the tubercles are all much larger in this region, and the wide depressed poriferous zones, and convex inter-ambulacral lobes, impart a lobed appearance to the circumference of the mouth.

*Affinities and differences.*—This species most nearly resembles *Stomechinus gyratus,* but is distinguished from it by the absence of the naked median depressions in the inter-ambulacral areas, which gives such a remarkable lobed character to the surface of its test; by the absence of the circles of granulations around the base of the tubercles; and the naked appearance which the surface of the plates presents, in consequence of the almost total absence of this granular ornamentation, and which is expressed by its specific name *nudus.*

*Locality and Stratigraphical position.*—This Echinite was collected in Wiltshire, but I have not been able to ascertain the correct locality; it appears to have been obtained from the Coral Rag, although this is not certain.

# NOTES

## On Foreign Jurassic species of the genus STOMECHINUS, nearly allied to British forms, but which have not been found in the English Oolites.

Stomechinus multigranularis, *Cotteau.* Syn. *Echinus multigranularis,* Cotteau. Études sur les Échinides Fossiles, pl. 7, figs. 6—8.

Test conoidal, with inflated sides, and a sub-pentagonal circumference; ambulacra narrow and prominent, with four rows of tubercles; inter-ambulacra more than three times as wide, with a naked median depression in the upper part of the area, and from eight to ten rows of tubercles, irregularly disposed, in the widest part, diminishing to two rows above; tubercles nearly all of the same size, except at the base, where they are larger; intermediate space filled with fine granules. Apical disc moderately large; genital plates pentagonal, with a granular surface; vent sub-circular; base flat; mouth opening very large, half the width of the test; peristome decagonal, with ten wide, obtuse notches, and small inter-ambulacral lobes between.

*Dimensions.*—Height, one inch and seven twentieths; transverse diameter, one inch and three quarters.

*Formation.*—Bathonien, Great Oolite, of Grimaux, Yonne: very rare.

*Collections.*—M. Rathier; a plaster mould in my cabinet.

Stomechinus Vacheyi, *Cotteau.* Syn. *Echinus Vacheyi,* Cotteau. Études sur les Échinides Fossiles, pl. 3, figs. 12—16.

Test small, depressed, and pentagonal; ambulacra with two rows of tubercles; inter-ambulacra with two rows of primary tubercles, and a few scattered secondary tubercles; mouth opening large; peristome with small notches.

*Dimensions.*—Height, three tenths of an inch; transverse diameter, six tenths of an inch.

*Formation.*—Bathonien, "dans les couches calcaires du Forest-marble, de Montillot, Yonne." *Cotteau.*

*Collection.*—M. Cotteau, a single specimen.

STOMECHINUS POLYPORUS, *Agassiz.* Syn. *Echinus polyporus,* Agassiz. Catalogue syst., p. 12.

Test hemispherical, circular depressed; ambulacra with four rows of tubercles; inter-ambulacra with close-set tubercles at the base and circumference, which rapidly diminish on the upper surface. It is distinguished from *Stomechinus bigranularis* by having four rows of tubercles in the ambulacra.

*Formation.*—Bathonien de Ranville? Rare.

*Collection.*—M. Michelin.

STOMECHINUS CAUMONTI, *Desor.* Synopsis des Échinides Fossiles, p. 128.

Test sub-conoidal, inflated at the sides; ambulacra with four rows of tubercles, the two internal rows short and less regular; inter-ambulacra with from eight to ten rows of tubercles at the circumference, which diminish little in size at the upper surface; mouth opening very large. "This species is found to be one of the most characteristic of the Bathonien stage." *Desor.*

*Formation.*—"Marnes à *Ostrea acuminata* (Vesulien) de Herznach (Argovie). Kellovien de Châtillon-sur-Seine."

*Collections.*—"Hébert, Mæsch, Mus. Zurich. Assez abondante." *Desor.*

STOMECHINUS APERTUS, *Desor*. Synopsis des Échinides Fossiles, p. 127.

Test sub-conical, pentagonal; ambulacra with two rows of tubercles, a little less in size, but more numerous than in the inter-ambulacra, which have six rows of tubercles at the circumference; mouth opening very large. "This species was formerly confounded with *Echinus excavatus*, Goldf., which has the ambulacral tubercles much smaller, and set more close together than those of the inter-ambulacra, whilst in *Stomechinus apertus* their difference in size is scarcely perceptible." *Desor*.

*Formation*.—Kellovien de marolles près Mamers, Courgains, Nantua. Rare.

*Collections*.—M. Michelin, d'Orbigny, Paris Museum.

STOMECHINUS ROBINALDINUS, *Cotteau*. Syn. *Echinus Robinaldinus*, Cotteau. Études sur les Échinides Fossiles, pl. 22, figs. 1—6.

Test sub-conoidal, inflated at the sides; circumference sub-circular; ambulacra with four regular rows of tubercles, identical with those of the inter-ambulacra; poriferous zones wide, trigeminal ranks very oblique; inter-ambulacra double the width of the ambulacra, and covered throughout with equal-sized tubercles, regularly disposed in numerous series, six tubercles on each plate; apical disc composed of equal-sized genital plates; vent large; mouth opening moderate in width, in the proportion of one to two and a half; peristome decagonal, with wide, obtuse notches.

*Dimensions*.—Height, one inch and a half; transverse diameter, two inches and one fifth.

*Formation*.—"Cette espèce caractérise les couches supérieures de l'étage Corallien et n'a jamais été rencontrée dans le Coral-rag inférieur de Châtel-Censoir et de Druyes." *Cotteau*.

*Collection*.—M. Robineau-Desvoidy. Very rare; only three specimens known.

STOMECHINUS ORBIGNYANUS, *Cotteau.* Syn. *Echinus Orbignyanus*, Cotteau. Études sur les Échinides Fossiles, pl. 21, figs. 8—13.

Test hemispherical, depressed; circumference circular; ambulacra with two marginal rows of tubercles, and a naked zone between: inter-ambulacra with six rows of tubercles at the equator, diminishing to two rows above; base concave; mouth opening wide, half the diameter of the test; peristome pentagonal, deeply notched.

*Dimensions.*—Height, six tenths of an inch; transverse diameter, one inch and one twentieth.

*Formation.*—"Calcaires marneux et lithographiques de Commissey Corallien étage." *Cotteau.*

*Collection.*—M. Rathier. Very rare.

STOMECHINUS EXCAVATUS, *Goldfuss.* Syn. *Echinus excavatus*, Goldfuss. Petrefacta. Germaniæ, tabl. 40, fig. 12.

Test hemispherical, depressed, sub-pentagonal; ambulacra with two marginal rows of close-set tubercles, smaller than those of the other areas; inter-ambulacra with two rows of primary tubercles on the sides, and four other secondary rows at the base.

*Dimensions.*—Height, eleven twentieths of an inch; transverse diameter, one inch.

*Formation.*—"Findet sich in den obersten Schichten des Jurakalkes bei Regensburg und in Schwaben." *Goldfuss.*

*Collection.*—Munich Museum. Very rare.

STOMECHINUS SERIALIS, *Agassiz.* Syn. *Echinus serialis*, Agassiz. Échinod. Foss. Suisse, II, tabl. 22, figs. 10—12.

Test circular, much depressed; ambulacra with two regular rows of tubercles; poriferous zones very narrow; inter-ambulacra with six rows of tubercles at the circumference, diminishing to two rows above; mouth opening very large; peristome decagonal, with obtuse notches.

*Dimensions.*—Height, four tenths of an inch; transverse diameter, three quarters of an inch.

*Formation.*—"Corallien infér. (Terrain à Chailles) du Fringeli (Jura Soleurois)." *Desor.*

*Collection.*—M. Gressly. Very rare.

STOMECHINUS LINEATUS, *Goldfuss.* Syn. *Echinus lineatus,* Goldfuss. Petrefacta Germaniæ, tabl. 40, fig. 11.

Test hemispherical, depressed, circular, or slightly sub-pentagonal; ambulacra with two rows of tubercles on the margins, and two small rudimentary rows internal to them; inter-ambulacra with six rows of tubercles at the circumference, diminishing to two rows above; tubercles of both areas prominent, and nearly of the same size; bosses encircled with granules; the general surface is very tuberculous.

*Dimensions.*—Height, one inch; transverse diameter, one inch and three quarters.

*Formation.*—From the Coral Rag of Regensburg and Basel. The specimen kindly sent me by M. Michelin is from the Coral Rag of Niederdoff, Canton de Bâle.

*Collections.*—Museums of Tübingen, Besançon, Munich, collection of M. Michelin. Royal College of Surgeons (Hunterian Collection), my cabinet.

STOMECHINUS PERLATUS, *Desmarest.* Syn. *Echinus perlatus,* Agassiz. Echinoderm. Foss. Suisse, part ii, pl. 22, figs. 13—15.
*Knorr.* Petrefact., ii, tab. E, figs. 1, 2.

Test conoidal, sub-circular, or sub-pentagonal; the transverse and bucco-anal diameters are sometimes nearly equal; ambulacra with two complete rows of tubercles on the margins, two incomplete rows within, and numerous small granules encircling their bosses; inter-ambulacra with ten rows of small tubercles at the circumference, two rows of which are larger, and extend from the peristome to the disc, the others disappear on the upper surface; the bosses of all the tubercles are surrounded by fine granules, which imparts a highly sculptured appearance to the test of this species; poriferous zones narrow, trigeminal ranks, form angles of 50° to 55°; apical disc moderate, ovarial plates large; mouth

opening very large, half the diameter of the test; peristome pentagonal, the ten notches wide and obtuse, with small lobes between.

*Dimensions.*—Specimen figured by M. Agassiz: height, one inch and three quarters; transverse diameter, two inches and four tenths.
Specimen in my cabinet: height, one inch; transverse diameter, one inch and nine tenths.

*Formation.*—Corallien infér. (Terrain à Chailles) de la Combe d'Échert (du Val de Moutiers), de Salins. Corallien étage Commercey (Meurthe), Châtel-Censoir, et Druyes (Yonne).

*Collections.*—Museums Neuchâtel, Bâle, Porrentruy. Collection of M. Michelin. British Museum, my cabinet.

STOMECHINUS SEMIPLACENTA, *Desor*. Cotteau, Études sur les Échinides Foss., pl. 45, fig. 5.

Test sub-circular, sub-inflated above, concave below; ambulacra with four rows of tubercles; inter-ambulacra with ten rows of tubercles at the circumference, irregularly disposed, diminishing on the upper surface; tubercles of both areas nearly equal-sized, and each surrounded by circles of granules; mouth opening very large; peristome decagonal, notches very wide and deep.

*Dimensions.*—Height, nine tenths of an inch; transverse diameter, one inch and seven tenths.

*Formation.*—" Kimméridge étage des environs de Chablis et Havre." *Cotteau.*

*Collections.*—MM. Rathier, Royer.

## *Family* 5—SALENIADÆ.

This natural family nearly corresponds to the Salénies of MM. Agassiz and Desor, and is distinguished from other families of the ECHINOIDEA ENDOCYCLICA by the peculiar structure and great development of the apical disc, which, besides the five genital and five ocular plates, has an additional or sur-anal plate, developed in the centre of the disc, immediately before the anal opening; this plate is sometimes single, or more frequently is composed of from three to eight separate elements.

The test is thin, and in general small, spheroidal, hemispherical, or depressed: the ambulacral areas are always narrow, straight, or flexuous, with two rows of small tubercles which alternate with each other on the margins of the area.

The poriferous zones are narrow, the pores unigeminal, except near the peristome, where they fall into oblique ranks of threes.

The inter-ambulacral areas are wide, with two rows of primary tubercles, which have large bosses with crenulated summits; in one section the tubercles are perforated, in the other they are imperforated.

The mouth opening differs in size in the different genera; the peristome is more or less decagonal, and is sometimes deeply notched, or only feebly indented. The jaws are known in one genus, in which they resemble those of *Hemicidaris*.

The spines of one section (the *Acrosalenia*) are only known; in this genus, the stems are long, slender, angular, or flattened, and the surface, although apparently smooth, is covered with very fine longitudinal lines.

From a misconception of the true relative position of the elements of the apical disc, in this family, much confusion exists in the works of different authors in the description of this part of the test. "The great difficulty in the study of this group," says M. Desor,* "is to find the place of the madreporiform body; we are consequently embarrassed when we attempt to assign the lateral parts to the longitudinal axis of these animals; unless we admit that the sur-anal replaces the madreporiform body; but this would be contrary to all analogy, because in all the other Cidarides, the madreporiform body is an integral part of one of the genital plates. M. Agassiz had got rid of the difficulty by means of an hypothesis, by admitting that the sur-anal plate is invariably placed in the plane of the animal, that it therefore could only be anterior or posterior; hence his two divisions in the genus *Salenia*,—the first with a sur-anal plate posterior, and, consequently, with the *périprocte* excentral and before; the second with the sur-anal plate anterior, and, consequently, with the *périprocte* excentral and behind."†

* 'Synopsis des Échinides Fossiles,' p. 138.

† For further details on this subject, M. Agassiz's 'Monographies d'Échinodermes, première Monographie des Salénies,' may be consulted.

Professor Johannes Müller assigns the left posterior genital plate as the bearer of the madreporiform body in *Salenia personata*. "Dies wird auch durch die Salenien bestätigt, wo die Längsachse durch die plaque suranale vor dem After bestimmt wird. An einem im mineralogischen Museum aufbewahrten ausgezeichnet schönen Exemplar der *Salenia personata*, Ag., mit vorderem After, Taf. 1, Fig. 9, ist die linke hintere Genitalplatte porös und Madreporenplatte."*

I have selected fine specimens of *Hyposalenia Wrightii*, Desor, from the Lower Green Sand, *Salenia petalifera*, Desmarest, from the Upper Green Sand, and *Salenia Austeni*, Forbes, from the Lower Chalk, in all of which the madreporiform body occupies the surface of the right anterior genital plate, as in the Cidaridæ, Hemicidaridæ, Diademadæ, and Echinidæ. The sur-anal plate is central, and the anal opening posterior, and inclined to the right side. In fact, the madreporiform body and sand canal, whatever their true functions may be, have the same position in all the Echinoidea, recent and fossil, which I have examined; and probably the same in all the Echinodermata. Professor Müller's mistake, therefore, may have arisen from his placing the *Salenia* in a false position before him.

The study of the apical disc in the *Acrosalenia* reveals the true relation of its elements to each other, and proves that the sur-anal plate has nothing in common with the spongy madreporiform body which occupies the surface of the right anterior genital plate (Pl. XV, fig. 4 *a*, *i*). I had the good fortune to make this discovery some years† ago, when figuring and describing *Acrosalenia hemicidaroides*, which urchin has furnished the key to the true relation of the bilateral parts to the longitudinal axis of the Saleniadæ. On this point M. Desor observes:

"Nous devons en outre à M. Wright une autre découverte plus importante, celle du corps madréporiforme, qui fait partie intégrante de l'une des plaques génitales comme dans les autres Cidarides. Or comme nous savons maintenant que cette plaque a une position fixe dans tous les oursins, nous sommes par là même en mesure de déterminer l'avant et l'arrière de ces animaux; et puisque les plaques sur-anales sont situées en arrière de cette plaque, il s'ensuit que le périprocte se trouve réellement refoulé en arrière. Il ne peut dès-lors plus être question d'Acrosalénies à périprocte eccentrique en avant, comme on supposait que c'était le cas de l'*Acrosalenia tuberculosa*," &c.

"Il n'arrive que trop souvent que le disque apicial manque, et dans ce cas, il est très-difficile de distinguer les Acrosalénies du genre Hemipedina décrit ci-dessus. Cependant, comme par suite du refoulement du périprocte en arrière la plaque génitale impaire ou postérieure gagne plus que les autres sur le test, on peut encore, d'après M. Wright, reconnaître la place de cette plaque même dans les individus dépourvus d'appareil apicial."‡

* Joh. Müller, 'Über den Bau der Echinodermen,' p. 7.

† Wright, 'Annals and Magazine of Natural History,' 2d series, vol. viii, p. 261.

‡ 'Synopsis des Échinides Fossiles,' p. 140.

A Table showing the Classification of the SALENIADÆ.

| Family. | Sections. | | Diagnosis. | Genera. |
|---|---|---|---|---|
| SALENIADÆ. | Section A. | Tubercles perforated. Apical disc small. | Inter-ambulacral tubercles large; apical disc small and not prominent; sur-anal plate composed of one or many pieces; vent posterior and excentral. | Acrosalenia, *Agassiz*. |
| | Section B. | Tubercles imperforate. Apical disc large, shield-like, and prominent. | Inter-ambulacral tubercles moderate; apical disc large and prominent; genital plates in the form of elongated lobes; sur-anal plate single; vent posterior and slightly excentral. | Peltastes, *Agassiz*. |
| | | | Inter-ambulacral tubercles large, few in number; apical disc large, and forming a regular pentagon, with elevated angular carinæ independent of the sutures; sur-anal plate angular; vent large, excentral, oblong, and posterior. | Goniophorus, *Agassiz*. |
| | | | Inter-ambulacral tubercles large; apical disc large, prominent, and shield-like; border undulated, with punctuations or sculpture in the lines of the sutures: sur-anal plate single, central; vent excentral, posterior, and inclined to the right side. | Hyposalenia, *Desor*. |
| | | | Inter-ambulacral tubercles very large; apical disc large and very solid, with an undulated circumference; surface of the large plates ornamented with punctuations, or sculptured figures along the line of the sutures; sur-anal plate single; vent excentral, and directed towards the right side. | Salenia, *Gray*. |

## *Genus*—ACROSALENIA. *Agassiz*, 1840.

This genus is composed of small or moderate-sized urchins with a thin spheroidal, hemispherical, or depressed test.

The ambulacral areas are narrow, straight, or slightly undulated, with two rows of small crenulated and perforated tubercles on their margins, which diminish gradually in size from the base to the apex.

The inter-ambulacral areas are wide, having two rows of primary perforated tubercles, raised on large prominent bosses with crenulated summits.

The apical disc is proportionally smaller than in other genera of the SALENIADÆ, and forms no prominence on the surface of the test; the sur-anal plate, sometimes single, is in general composed of many separate pieces placed before the anal opening, which renders it excentral and displaces the vent backwards; the anterior pair of genital plates are larger than the posterior pair, and the single plate is small and crescentic; the spongy madreporiform body occupies the right anterior genital plate.

The mouth opening is large, often one half the diameter of the test; the peristome is decagonal, with ten wide notches which have the margin reflected over their border.

The primary spines are long, circular, flattened, or angular; and they are sometimes twice the length of the diameter of the body; although apparently smooth, still with a lens, their surface is seen to be covered with fine longitudinal lines. The secondary spines are short, regular, round, and striated.

The *Acrosalenias* are found in the different stages of the Oolitic rocks from the Lias to the Portland, but they are most numerous in the lower division of the Oolites; recent researches have shown that this genus contains a much larger number of species than was originally supposed, when many of them were erroneously referred to other genera, in consequence of the apical disc being absent in a very great number of specimens.

When the apical disc is absent, an *Acrosalenia* may be easily mistaken for a *Hemicidaris*, but the aperture in *Acrosalenia* is always larger, and one of its angles projects further into the single inter-ambulacrum than into the others; the posterior pair of ambulacra are more curved backwards than the anterior pair, and the single anterior area is always straight; it requires a considerable practice of the eye and the handling of many specimens, before we can determine accurately by these characters; but practice has convinced me of their value, and I have now no difficulty in distinguishing an *Acrosalenia*, whether the disc be present or not. The absence of true semi-tubercles from the base of the ambulacral areas, likewise assists in the diagnosis.

### A. *Species from the Lias.*

ACROSALENIA MINUTA, *Buckman.* Pl. XV, fig. 3 *a, b, c;* Pl. XVII, fig. 2 *a, b, c, d, e.*

| | |
|---|---|
| ECHINUS MINUTUS. | Buckman, in Murchison's Geology of Cheltenham, 2d ed., p. 95. |
| ACROSALENIA CRINIFERA. | Wright, Annals and Magazine of Natural History, 2d series, vol. xiii, p. 168, pl. 12, fig. 1. |
| — — | Forbes, in Morris's Catalogue of British Fossils, 2d edition. Additional species of Echinodermata. |
| — MINUTA. | Oppel, die Jura Formation Englands, Frankreichs, und des südwestlichen Deutschlands, p. 110. |

Test circular, depressed; ambulacral areas very narrow, with two rows of microscopic tubercles placed at some distance apart on the sides of the area, those on the right side alternating with those of the left; inter-ambulacral areas with two rows of primary tubercles, from nine to ten in each row, so disposed that the test appears, from the narrowness of the ambulacra, to possess only ten rows of tubercles, nearly equidistant from each other; spines long, numerous, and hair-like.

*Dimensions.*—Height, three twentieths of an inch; transverse diameter, six twentieths of an inch.

*Description.*—This beautiful little urchin has been long known to our local geologists, as it was obtained in great numbers when cutting through the Oxynotus bed of the Lower Lias in the formation of the Birmingham and Bristol Railway; it has often been a palæontological puzzle, for although a few specimens have been found in a tolerable state of preservation, still, for the most part, the test is so much injured by pyrites, that it requires a good lens, and much patient study, to make out the details of its structure. I lately found a very good specimen in the Oxynotus shales near Lansdown, which forms the subject of fig. 2, Pl. XVII, and is the most perfect example I have seen. In my 'Memoir on the Lias Echinodermata,' I figured and described this species as *Acrosalenia crinifera*, Quenst., but my friend Dr. Oppel, of Stuttgart, having kindly sent me the type of Quenstedt's species, I am satisfied, from the comparative shortness of the spines of our urchin, that it is distinct from that form, and have, therefore, restored its original specific name, *minuta*.

The test is nearly circular, and is more or less depressed; the ambulacral areas are extremely narrow (Pl. XVII, fig. 2 *d*), with two rows of minute marginal tubercles, not much larger than the common granulation of the test; these tubercles are placed in each row at some distance apart (fig. 2 *e*), and the tubercles of the one side alternate with those of the opposite (fig. 2 *b*); between these two rows of tubercles there is a narrow, zigzag line of granulations; the tubercles are very uniform in size throughout the area, but to see

them satisfactorily it is necessary to examine the test with a microscope under an inch object-glass.

The poriferous zones are extremely narrow; the pores are small, there being four pairs opposite each tubercular plate; the septa are slightly elevated, and form a microscopic moniliform line between the pores (fig. 2 *e*).

The inter-ambulacral areas are wide (fig. 2 *b*, *c*), with two rows of primary tubercles, from nine to ten in each row; they are situated near the zonal sides of the plates, and have a wide miliary zone between them; the bosses have deeply crenulated summits, and the tubercles are small and widely perforated; well-defined areolas encircle the bosses (fig. 2 *e*), which are confluent above and below; the miliary zone consists of an elevated band, composed of from four to six rows of small, unequal-sized granules (fig. 2 *e*), which extend from the peristome to the disc. When viewed with the naked eye, at the equator, this tiny urchin appears to possess only ten rows of tubercles, nearly equidistant from each other (fig. 2 *a*), but when examined with a microscope its true structure is seen; the extreme narrowness of the ambulacral areas, with their close, alternate rows of microscopic tubercles, and the width of the miliary zone, with its unequal-sized granules, alike contribute to make the deception almost complete (fig. 2 *b*).

The opening for the disc is nearly one half the diameter of the test, but I have never seen the trace of a plate in any specimen I have examined (fig. 2 *c*).

The mouth opening is small, about one third the diameter of the test, and lies in a concave depression (fig. 2 *b*); the peristome is feebly notched, and the lobes are of unequal size (fig. 2 *b*).

The most remarkable portions of the structure of this tiny fossil are the spines, which, in some crushed specimens, are preserved *in situ* between the laminæ of the Lias shales; they are long, slender, and hair-like, with a well-developed head; on some slabs these spines resemble so many fine bristles, laid down in all directions, upon the surface of the laminated Oxynotus shales; in one crushed test, four tenths of an inch in diameter, the spines measured upwards of an inch in length.

*Affinities and differences.*—The smallness of the test, and the length and hair-like character of the spines, are sufficient to distinguish *Acrosalenia minuta* from all other Lower Lias urchins. In the shales of the Upper Lias, there is another small urchin with long, hair-like spines; but I have never yet succeeded in obtaining a specimen in sufficient preservation to enable me to institute a comparison between it and *Acrosalenia minuta*; the Upper Lias form reminds me very much of *Cidarites crinifera*, Quenstedt, from the "Posidonienschiefer von Pliensbach bei Boll in Würtemberg," a bed of the Upper Lias.

*Locality and Stratigraphical position.*—*Acrosalenia minuta* was found in the laminated Oxynotus shales of the Lower Lias at Lansdown, Cheltenham, and likewise at Gloucester, whilst excavating the same bed to form a new dock. It was associated in both places with

*Ammonites oxynotus*, Quenstedt, and *Ammonites raricostatus*, Zieten; these Ammonites characterise the horizon of this species in a very definite manner. I have lately received the spines of this urchin, which were collected from the Lower Lias near Stratford-on-Avon.

Dr. Oppel states that *Acrosalenia minuta* is found in the Lower Lias of Württemberg. "Die flachgedrückten Körper mit den feinen Stacheln füllen eine ganze Schichte in der Region des *Pentacrinus tuberculatus*. Sie liegen häufig verkiest in den bituminösen Schiefern des untern Lias an der Steinlach bei Dusslingen, und wurden von meinem Freund Dr. Rolle zuerst darin aufgefunden."*

*History.*—First described by Professor Buckman, in the 'Geology of Cheltenham,' as *Echinus minutus*. Afterwards, in my 'Memoir on Lias Echinodermata,' it was figured for the first time, and described as *Acrosalenia crinifera*, Quenst.; a comparison of our species with the German urchin has induced me to restore its original specific name. It has been subsequently found by Dr. Rolle in the *Tuberculatus* bed at Steinlach.

B. *Species from the Inferior Oolite.*—10$^{e}$ *Étage Bajocien*, D'Orbigny.

ACROSALENIA LYCETTII, *Wright*. Plate XVI, fig. 1 *a*, *b*, *c*, *d*, *e*, *f*.

| | | |
|---|---|---|
| ACROSALENIA LYCETTII. | | Wright, Annals and Magazine of Natural History, 2d ser., vol. viii, p. 263, pl. 11, fig. 2. |
| — | — | Forbes, in Morris's Catalogue of British Fossils, 2d ed., p. 70. |
| — | — | Desor, Synopsis des Échinides Fossiles, p. 142. |

Test hemispherical, much depressed on the upper surface, and flat at the base; circumference circular or sub-pentagonal; ambulacral areas narrow, with two rows of prominent tubercles on the margins; inter-ambulacral areas wide, the two rows of tubercles with very large, prominent bosses; miliary zone with two rows of granules at the equator, and a naked median depression between the three upper pairs of tubercles; apical disc small and prominent; sur-anal plate single; vent small, and transversely oblong.

*Dimensions.*—Height, half an inch; transverse diameter one inch.

*Description.*—This urchin at first sight so much resembles a *Hemicidaris* that it might readily be mistaken for one, in consequence of the size of the ambulacral, and the prominence of the bosses of the inter-ambulacral tubercles; but a more careful study of the test soon discloses its true generic character.

A transmutationist will doubtless find it a difficult matter to discover the progenitor of this urchin; it makes its appearance in the lowest beds of the Inferior Oolite, with all its Acrosalenian characters so strongly developed, that it may be taken as a good type of the

* Dr. Oppel, die Jura Formation, p. 110.

genus. This is not the only example among fossil Echinodermata illustrative of the fact, that the first created forms of new types of life are often the most characteristic of the group they represent; the figure and description of the first species of every genus contained in this Monograph is, in fact, a practical commentary on this great natural law.

The ambulacral areas are narrow, straight, and prominent; they have two rows of small, well-developed tubercles, from twelve to fourteen in each row, disposed on the margins of the areas, which gradually diminish in size from the base to the apex (fig. 1 *a*, *b*); a zigzag line of small granules descends down the centre, sending lateral branches between every two tubercles; this granular network encircles three parts of the areolas, and leaves them open only to the poriferous zones (fig. 1 *d*); the tubercles at the base of the area (fig. 1 *b*, *e*) are large, and remind us of the semi-tubercles in this region in *Hemicidaris*.

The poriferous zones are narrow; the pores are unigeminal, except at the base, where they fall into oblique ranks of threes (fig. 1 *e*); there are eleven pairs of pores opposite two large plates (fig. 1 *d*).

The inter-ambulacral areas are three times and a half as wide as the ambulacral; there are eight tubercles in each row, which, at the circumference, are raised on very large prominent bosses (fig. 1 *a*, *c*); one of these mammæ, drawn in profile (fig. 1 *f*), shows its conical form; it is surrounded by a wide, oval areola (fig. 1 *d*), which is confluent with its fellow above and below; the tubercles are large at the base, but suddenly diminish in size in the upper part of the area; there are ten crenulations on the summits of the bosses, and the tubercles are small in proportion to the magnitude of these eminences; the two rows of tubercles are separated by a zigzag granular band, or miliary zone, in the centre of the area (fig. 1 *c*), consisting of two rows of granules, and a few additional smaller ones dotted here and there in the interspaces; similar crescentic bands of granules separate the areolas from the poriferous zones; each plate, therefore (fig. 1 *d*), has a semi-circular row of granules, with a few granulets, on its central side, and a similar row on its zonal side, whilst the upper and lower borders are destitute of sculpture. On the upper part of the area the granules disappear, and leave a small, naked, median depression between the three uppermost pairs of small tubercles (fig. 1 *a*).

The base is flat, or slightly concave (fig. 1 *c*); the mouth opening is large, one half the diameter of the test; the peristome is decagonal, and divided by wide notches into unequal-sized lobes, the ambulacral being one half larger than the inter-ambulacral lobes (fig. 1 *b*), and its margin is folded over at the angles of the notches (fig. 1 *c*).

The small apical disc is very seldom preserved; fortunately I lately found one specimen with most of the plates *in situ* (fig. 1 *a*), and another with the sur-anal plate, which is single, or more probably composed of three plates soldered together; it is the only specimen I have seen with this portion of the disc, the coarse character of the Pea-grit in which they are found being unfavorable for the preservation of this fragile and complex part of the shell.

*Affinities and differences.*—This species resembles *Acrosalenia hemicidaroides*, Wright, but is distinguished from it by having the test more depressed, the ambulacral tubercles larger and more prominent, the three upper pairs of the primary inter-ambulacral tubercles smaller, with a naked median depression in the centre of the upper part of the miliary zone; the apical disc is likewise smaller. The size and prominence of the ambulacral tubercles form a distinctive character between *Acrosalenia Lycettii* and *Acrosalenia pustulata* on the one side, and *Acrosalenia Wiltonii* on the other, both of which have small and widely spaced-out tubercles in the ambulacral areas.

*Locality and Stratigraphical position.*—I have collected this urchin from the lower ferruginous beds of the Inferior Oolite, the Pea grit, at Crickley, Leckhampton, and Cooper's Hills; from a sandy seam of the lower beds of the Inferior Oolite at Stinchcombe; and likewise from the lower beds of the Inferior Oolite at Brockhampton, Cleeve, and Sudely Hills. It occurs likewise in the shelly beds of the Roe-stone at Leckhampton, and has been catalogued in the Rev. P. B. Brodie's paper* as *Acrosalenia Hoffmani*, Römer. Although an abundant species, it is seldom found in good preservation, the shell being always more or less crushed; it is commonly associated with *Pseudodiadema depressum*, Agass., which it somewhat resembles, but is easily distinguished from that form by the disproportion between the size of the ambulacral and inter-ambulacral tubercles.

*History.*—It was first figured and described in my 'Memoir on the Cidaridæ of the Oolites,' and is dedicated to my friend John Lycett, Esq., one of the learned authors of the 'Monograph on the Mollusca of the Great Oolite,' which has already enriched the volumes of the Palæontographical Society.

C. *Species from the Great Oolite, Bradford Clay, Forest Marble, and Cornbrash.*—11$^{e}$ *Étage Bathonien*, D'Orbigny.

ACROSALENIA HEMICIDAROIDES, *Wright.* Pl. XV, fig. 4 *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *l*, *m*.

| | | |
|---|---|---|
| ACROSALENIA HEMICIDAROIDES. | | Wright, Annals and Magazine of Natural History, 2d ser., vol. viii, p. 161, pl. 11, fig. 1. |
| — | — | Forbes, Memoirs of the Geological Survey, Decade IV, pl. 2. |
| — | — | Forbes, in Morris's Catalogue of British Fossils, 2d edit., p. 70. |
| — | — | Desor, Synopsis des Échinides Fossiles, p. 144. |

* 'Quarterly Journal of the Geological Society,' vol. vi, p. 247.

Test hemispherical, more or less depressed, sometimes elevated; ambulacral areas narrow, undulated, with two rows of small, perforated tubercles, fourteen to sixteen in each row, which alternate on the borders of the area, and gradually diminish in size from the base to the apex; inter-ambulacral areas with large prominent tubercles on the sides, and small tubercles near the disc; areolas sub-confluent; miliary zone narrow, with two rows of granules; apical disc very large; sur-anal plate composed of six elements; mouth large, decagonal; peristome deeply notched; primary spines twice or more in length the diameter of the test; stem sub-angular, tapering, or slightly compressed; extremity sometimes bifid or trifid.

*Dimensions.*—This species varies so much in size and figure, that I have selected four specimens on account of their differences, the comparative dimensions of which are shown in the following table:

| *Acrosalenia hemicidaroides.* Wright. | Largest form. | Elevated form. | Depressed form. | Common small form. |
|---|---|---|---|---|
| | Inch. | Inch. | Inch. | Inch. |
| Transverse diameter of test . | $1\frac{4}{10}$ | $1\frac{3}{20}$ | $1\frac{1}{10}$ | $0\frac{6}{10}$ |
| Height of test . . . | $0\frac{9}{10}$ | $0\frac{7}{10}$ | $0\frac{6}{10}$ | $0\frac{1}{3}$ |
| Diameter of mouth opening . | $0\frac{7}{10}$ | $0\frac{11}{20}$ | $0\frac{1}{2}$ | $0\frac{1}{3}$ |
| Length of apical disc . . | $0\frac{5}{10}$ | $0\frac{9}{20}$ | $0\frac{4}{10}$ | $0\frac{3}{10}$ |

*Description.*—This is the most common and best preserved of all our fossil sea-urchins; it has long been known as a Cornbrash species, but was neither named, figured, nor described, until I gave its history, with figures and details, in my 'Memoir on the Cidaridæ of the Oolites;' since then it has been figured and described by Professor Forbes in the fourth Decade of the 'Memoirs of the Geological Survey;' and by M. Desor, in tabl. XX, figs. 19—23, of his valuable 'Synopsis des Échinides Fossiles.' This species exhibits much variation in size and figure, but its diagnostic characters are preserved with remarkable uniformity throughout these different phases of form and magnitude.

The test is sometimes elevated and globular, like a *Hemicidaris;* indeed, the large forms, the dimensions of which are given in the first column of the table of measurements, are commonly so named; the absence of semi-tubercles at the base of the ambulacra, and the large size of the elongated discal opening, are the only characters by which they can be distinguished from that genus. In the more common form (fig. 4 *c*), the body is spheroidal and depressed on the upper surface; and, when the flattening is excessive, it produces the depressed form of the third column.

The ambulacral areas are narrow and moderately prominent (fig. 4 *a*); they are nearly of a uniform width, gradually expanding in the lower half, and tapering in

the upper; they exhibit a very slight undulating contour, and have two rows of small, nearly equal-sized secondary tubercles, from sixteen to eighteen in each row (fig. 4 *c*); the tubercles at the basal angle are the largest (fig. 4 *b*, *e*), and they imperceptibly diminish in size from the circumference to the disc (fig. 4 *a*), they are all perforated and raised on bosses, which have ten crenulations on their summits (fig. 4 *d*); the tubercles of each row alternate, and in the centre of the area there are one or two rows of granules, which send off small lateral branches to encircle the areolas (fig. 4 *d*, *e*).

The inter-ambulacral areas are nearly four times as wide as the ambulacral; they consist of two columns, each composed of seven or eight plates, each plate bearing a primary tubercle (fig. 4 *d*); the two plates nearest the peristome are very small (fig. 4 *b*), the four on the sides are very large (fig. 4 *c*), and the two near the disc are small (fig. 4 *a*); the tubercles are elevated on very large bosses (fig. 4 *f*), which have ten or more deep crenulations on their summits, the tubercles themselves are perforated; around the base of the boss there is a wide, smooth areola; the plates are bordered by a single row of granules (fig. 4 *d*), which, however, is sometimes absent from the upper and lower borders, the areolas then being confluent; the miliary zone is narrow, and is formed of two rows of granules, with the intermediate angles having a few smaller additional granules introduced; the areolas are separated from the poriferous zones by a row of granules on the zonal side of the plates (fig. 4 *d*).

The poriferous zones are narrow, the pores unigeminal throughout, except at the base, where they fall into triple oblique rows; the septa form small elevations on the surface, and a beaded line thereby passes down the zone between the pores forming a pair (fig. 4 *d*), and there are nine or ten pairs of pores opposite each tubercular plate.

The apical disc is often admirably preserved in this beautiful urchin; the study of its curious structure first enabled me to correct M. Agassiz's erroneous supposition, that the genital plate, which carries the madreporiform body, is the single plate, and represents the posterior side of the animal, instead of the right antero-lateral plate which occupies the same relative position in all the Echinoidea.

The disc is one third the width of the test, and in consequence of the projection of the genital plates has a pentagonal form; it is slightly convex and prominent, the anterior and posterior pair of genital plates are nearly of the same size (fig. 4 *a*, *i*), the right anterior is the largest, and carries on its front part the madreporiform body; the small crescentic-shaped single plate forms the posterior boundary of the vent (fig. 4 *i*); the oviductal holes are all near the apices; the sur-anal plate is composed of six or seven pieces arranged like mosaic before the anal opening; the ocular plates are small and firmly wedged between the genital and sur-anal elements. All the plates of the apical disc have numerous granules scattered on their surface.

The mouth opening is wide, nearly one half the diameter of the test; the peristome is decagonal; the ambulacral being larger than the inter-ambulacral lobes, the ten deep

notches, with reflected edges, indent the bases of the inter-ambulacra, and extend as far as the areolas of the second or third tubercles.

The primary spines are finely preserved *in situ* in fig. 4 *k*; they are variable in size in the same and in different specimens, and are proportionally shorter in young than in old urchins; sometimes they are three times the length of the diameter of the body (fig. 4 *b*), and are sometimes nearly three inches and a half in length; the head is conical, with a truncated extremity marked by deep crenulations (fig. 4 *m*), the ring is prominent, and the milling is angular and sharp; the stem (fig. 4 *b*) swells out beyond the ring, it is more or less irregularly sub-angular, with the angles rounded; a transverse section of one of the spines exhibits an irregularly elliptical figure; sometimes the spine tapers to a conical point, or the distal end terminates in a bifid or trifid extremity. The secondary spines articulating with the ambulacral tubercles (fig. 4 *n*) are short, about three tenths of an inch in length, they are round, and taper gently from the ring to the point, their surface being covered with fine longitudinal lines (fig. 4 *n*).

The jaws are preserved in one or two specimens (fig. 4 *g*); the lantern is strong (fig. 4 *h*), the teeth conical, and in its general appearance the dental apparatus closely resembles that of an *Echinus*.

*Affinities and differences.*—This urchin very much resembles a *Hemicidaris;* in fact, *Acrosalenia* and *Hemicidaris* have so many characters in common, which are always well preserved, and so few that are diagnostic, and which for the most part are either broken or absent, that it requires considerable practice, when the apical disc is wanting, to determine the genus; the absence of semi-tubercles at the base of the ambulacra and the magnitude and pentagonal form of the discal opening serve as good guides to the genus. *Acrosalenia hemicidaroides* is distinguished from *A. Lycettii* by having a larger and more spheroidal test, larger bosses on the sides, and smaller ambulacral tubercles; the apical disc is larger, and the sur-anal plate is composed of a greater number of pieces. *Acrosalenia hemicidaroides* is distinguished from *A. pustulata* in having regular rows of secondary tubercles in the ambulacral areas, which are larger and more fully developed; the miliary zone is narrower, with only two rows of granules; the primary tubercles are more developed at the upper surface, and the apical disc is likewise larger.

The same characters distinguish it from *A. Wiltonii;* but besides those already enumerated, that species has four rows of fine granules in the miliary zone, smaller tubercles, suddenly diminishing at the upper surface, and a much smaller mouth opening. The complex character of the sur-anal plate, the size of the test and of its primary tubercles, readily separate it from *A. spinosa*.

*Locality and Stratigraphical position.*—The finest specimens of this urchin with their spines attached (fig. 4 *k*) have been collected by Mr. William Buy, from the Forest Marble, near Malmesbury, in a thin vein of clay, which, according to that acute and

careful collector, separates the Cornbrash from the Forest Marble. The beauty of these specimens, and the admirable state of preservation in which they are found, forms one of the marvels of the Oolitic fauna; a great quantity of fine tests are collected from the gray brashy beds of the Cornbrash near Chippenham. Mr. Bristow obtained it from the Cornbrash near Wincanton; Mr. Pratt from the Forest Marble at Hinton Abbey; Mr. Hull found very large specimens in a cream-coloured, calcareous, semi-indurated, marly bed of the Great Oolite near Burford, in a quarry not far from the Bird-in-hand Inn. I discovered two specimens in the Great Oolite limestone of Minchinhampton Common. The specimens said to have been found in the Inferior Oolite have been ascertained to be *A. Lycettii*. The Rev. A. W. Griesbach collected quinquefid spines of this urchin in the Great Oolite at Wollaston, Northamptonshire, along with *Acrosalenia pustulata*. This species, therefore, belongs to the Bathonian stage, and is a very characteristic urchin of this great zone of life.

ACROSALENIA SPINOSA, *Agassiz*. Pl. XVII, fig. 3 *a, b, c, d, e, f*.

| | | |
|---|---|---|
| ACROSALENIA | SPINOSA. | Agassiz, Catalogus systematicus Ectyporum Echinodermatum fossilium, p. 9, 1840. |
| — | LÆVIS. | Agassiz, Catalogus systematicus Ectyporum Echinodermatum fossilium, p. 9, 1840. |
| — | SPINOSA. | Agassiz, Échinodermes Fossiles de la Suisse, ii, tab. 18, figs. 1—5, p. 39. |
| — | — | Cotteau, Études sur les Échinides Fossiles, pl. 3, figs. 6—11, p. 58. |
| — | — | Agassiz et Desor, Catalogue raisonné, Annales des Sciences Naturelles, 3$^{me}$ série, tome vi, p. 343. |
| — | — | Forbes, in Morris's Catalogue of British Fossils, p. 70. |
| — | — | Wright, Annals and Magazine of Natural History, 2d series, vol. viii, pl. 12, fig. 3, p. 265. |
| — | — | Bronn, Lethæa Geognostica, dritte Auflage, Band ii, tabl. xvii, fig. 7, p. 144. |
| — | — | Desor, Synopsis des Échinides Fossiles, tabl. 20, figs. 14—16. |
| — | — | D'Orbigny, Prodrome de Paléontologie, tome i, 11$^{me}$ étage, Bathonien, p. 320, No. 417. |
| — | RADIATA. | Forbes, Memoirs of the Geological Survey, IV Decade. Note on new species of British Acrosalenias. |

Test sub-pentagonal, depressed; ambulacra straight, prominent, with two marginal rows of small spaced-out tubercles ten to twelve in each row; inter-ambulacra with eight to nine primary tubercles in each row, large at the circumference, gradually diminishing towards the peristome, suddenly so on the upper surface; miliary zone narrow at the circumference, wide and naked in the middle at the upper surface; apical disc large, sur-anal plate single;

vent large, excentral; mouth large; peristome decagonal, lobes nearly equal; notches slightly incised.

*Dimensions.*—Height, nearly four tenths of an inch; transverse diameter, seven tenths of an inch.

*Description.*—This beautiful little urchin is so admirably preserved in the Corn-brash of Wiltshire, that it forms one of the most characteristic fossils of that formation; the test is small, sometimes circular, oftener sub-pentagonal, and always much depressed (fig. 3 *c*).

The ambulacral areas are narrow and prominent (fig. 3 *a*, *b*); as the poriferous zones are wide, for so small an urchin, the ambulacra appear isolated, and the upper surface of the test has a radiated appearance, which is increased by the size and smoothness of the apical disc (fig. 3 *a*); the ambulacra converge in straight lines from the base to the disc; they are furnished with two rows of small tubercles, which, although microscopic in size, have crenulated bosses and perforated summits; the tubercles are disposed with great regularity on the borders of the areas, at a moderate distance apart (fig. 3 *c*, *d*), so that there are only from ten to twelve in each row; in the middle of the area a double row of granules separates the tubercles, and lateral rows encircle the areolas, which are only open on the sides (fig. 3 *d*). The poriferous zones are wide and straight; the pores are large, and disposed obliquely in single pairs (fig. 3 *d*), forming a rectilinear file on each side of the ambulacral segments; there are from five to six pairs of pores opposite each large tubercular plate.

The inter-ambulacral areas are three times the width of the ambulacral; the two rows of tubercles, about eight in each row, are nearly equidistant throughout (fig. 3 *a*); the two basal pairs are small (fig. 3 *b*), the three equatorial pairs large (fig. 3 *c*), and the three upper pairs suddenly diminish in size and become dwarfed as they approach the disc (fig. 3 *a*, *c*); two or three pairs of tubercles at the equator have very large bosses (fig. 3 *e*), whilst all the others are of moderate size; they have narrow elliptical areolas, of which the larger are confluent (fig. 3 *d*); the miliary zone consists of two rows of granules, which form scrobicular circles around the areolas (fig. 3 *d*); as the rows diverge above, a small triangular space on the upper part of the segment is left naked (fig. 3 *a*); the areolas are likewise separated from the poriferous zones by a single row of granules (fig. 3 *d*).

The apical disc is large and pentagonal, about two fifths the diameter of the test (fig. 3 *a*); the anterior and posterior pair of genital plates are nearly alike in size and form (fig. 3 *f*); the oviductal holes are perforated near the external third of the plates; the posterior single plate projects a little further into its corresponding segment than the others, it is largely excavated for the vent, of which it forms the posterior wall (fig. 3 *f*); the sur-anal plate is central, single, and pentagonal, and forms the anterior wall of the vent (fig. 3 *f*), its sides being formed by the posterior pair of ocular plates, which are

much larger than the three others (fig. 3 *f*); the madreporiform body is very small, and occupies as usual the right anterior genital plate; a few small granules form central clusters on the pairs of genitals, and similar granules dot the surface of the small oculars (fig. 3 *f*).

The mouth opening is nearly half the diameter of the test (fig. 3 *b*); the peristome is decagonal, and divided by small notches into nearly equal-sized lobes; the incisions are not deep, and the margin is reflected over all the angles (fig. 3 *f*).

*Affinities and differences.*—This species is distinguished by its small size and depressed test, the extreme regularity of its tubercles, the radiated appearance of the upper surface, the apical disc having the sur-anal plate single, and the vent of a triangular form; these characters serve to distinguish it from all its other English congeners. It resembles *A. aspera* in many of its general characters, but that species has undulated ambulacral areas with close-set tubercles and the sur-anal plate composed of two pieces; it is so entirely distinct from all other forms of the genus at present known, that it is unnecessary to pursue a comparison with them.

*Locality and Stratigraphical position.*—I have collected two specimens of this urchin in the Pea grit, Inferior Oolite, at Crickley Hill, and in the yellow clay resting on the Stonesfield Slate at Sevenhampton, with *Anabacia orbulites*, *Pecten vagans*, *Ostrea acuminata*, and other Great Oolite fossils. I have likewise found it in the Great Oolite at Sham Castle, near Bath. Mr. Lycett has collected it from the Great Oolite of Minchinhampton Common, where it is small in size and rare. It is abundant in the Forest Marble and Cornbrash near Chippenham, with *Avicula echinata*, Sow., whence my finest specimens were collected by Mr. William Buy. It is found, likewise, in the Forest Marble and Cornbrash near Cirencester; indeed, it may be considered an abundant fossil in the English Cornbrash, but I have seen no specimens at all equal in their preservation and beauty to those found in Wiltshire.

In Switzerland it was collected by M. Strohmeyer from the marls containing *Ostrea acuminata*, in the canton of Soleure. In France it has been found in the Great Oolite of Ranville, Calvados, by Professor Deslongchamps, and in the upper beds of the Bathonien étage in the environs of Châtel-Censoir, by M. Cotteau.

Acrosalenia Loweana, *Wright*, nov. sp. Pl. XVII, fig. 4 *a*, *b*, *c*, *d*.

Test circular, much depressed; ambulacral areas narrow and sinuous, with marginal rows of very small wide-set tubercles; inter-ambulacral areas with six primary tubercles in each of the two rows, of which the two equatorial pairs are very large; apical disc of moderate size, sur-anal plate composed of three pieces; primary tubercles near the disc very small.

*Dimensions.*—Height, seven twentieths of an inch; transverse diameter, three quarters of an inch.

*Description.*—This small depressed urchin was kindly communicated to me by my friend Mr. S. P. Woodward, and is the only specimen of the form which has come under my notice. The test is circular, much depressed, and well characterised by the disproportionate magnitude of the equatorial tubercles, when compared with those on the upper and under surfaces of the test.

The ambulacral areas are narrow, and slightly undulated; they have two rows of very small tubercles on the margins, from twelve to fourteen in each row, placed wide apart from each other, with a few granules in the interspace (fig. 4 *c*); the poriferous zones are narrow and undulated, winding round the bulging areolas of the large equatorial tubercles; there are from eight to nine pairs of pores opposite the large tubercular plates (fig. 4 *c*), and the septa form mammillated elevations on the surface.

The inter-ambulacral areas are more than four times as wide as the ambulacral (fig. 4 *a*); they have only six plates in each column (fig. 4 *b*), each plate bearing a primary tubercle; the two equatorial plates support tubercles with very large prominent bosses (fig. 4 *b*), which are likewise surrounded by wide, smooth areolas; on three parts of the margin of these equatorial plates there is a continuous series of small granules, which are absent, however, from the lower border (fig. 4 *c*); on the smaller of the larger plates the bosses become suddenly less, and between the areola and the centro-suture there are three rows of granules (fig. 4 *c*); the uppermost plate has a mere rudimentary tubercle on its surface, surrounded with numerous granules (fig. 4 *a*); the basal tubercles likewise suddenly diminish in size towards the peristome; the zones expand in consequence, and the pairs of pores are disposed in oblique ranks of threes closely laid together.

The apical disc is of moderate size for the genus *Acrosalenia* (fig. 4 *a*); the four ovarial plates are shield-shaped, the anterior pair being a little larger than the posterior pair (fig. 4 *d*); the single ovarial plate is small and crescentic, the oviductal holes are perforated near their apices, and the small spongy madreporiform body occupies the centre of the right anterior (fig. 4 *d*); the sur-anal plate is composed of three pieces, one central pentagonal piece, and two small latero-posterior rhomboidal pieces, which form the anterior wall of the vent (fig. 4 *d*); the sides of this opening are formed by the posterior genital and ocular plates, and the posterior wall by the single crescentic genital (fig. 4 *d*); the three anterior ocular plates are heart-shaped, the posterior pair are rhomboidal, and the eye-holes are all marginal (fig. 4 *d*); all the plates are moderately large.

The base is flat, the mouth opening large, and the peristome decagonal; the notches are deep and have reflected margins; the opening is one half the diameter of the test, and the ambulacral are larger than the inter-ambulacral lobes.

*Affinities and differences.*—This urchin at first sight resembles some of the depressed

forms of *Acrosalenia hemicidaroides* (Pl. XV, fig. 4), but from these it is distinguished by having fewer primary tubercles in each row, the two equatorial pairs are disproportionately larger than the others, and those on the upper surface are rudimentary; the apical disc likewise is smaller, and the sur-anal plate is composed of three pieces, whilst in *A. hemicidaroides* it has six elements.

It is distinguished from *Acrosalenia spinosa* in having fewer primary tubercles in the inter-ambulacral areas, in having the ambulacral areas sinuous, the sur-anal plate with three elements, *A. spinosa* having only one (Pl. XVII, fig. 3 *f*); it is so entirely distinct from other congeneric forms that it is unnecessary to make a comparison with them.

*Locality and Stratigraphical position.*—This urchin was collected from the Forest Marble at Malmesbury, and belongs to the British Museum; the honour of detecting the species is due to Mr. Woodward, who has kindly communicated it for this work.

I have much pleasure in associating the name of my friend Josiah Graham Lowe, Esq., of Kensington Park, with this Forest Marble species, as a tribute of gratitude for his kindness in presenting me with several rare and valuable specimens for this Monograph, and as an acknowledgment of the valuable service he has rendered to the palæontology of the Forest Marble and Cornbrash formations, so well developed in Wiltshire, in making the finest collection extant from these rich fossiliferous deposits

ACROSALENIA PUSTULATA, *Forbes.* Pl. XVI, fig. 2 *a*, *b*, *c*, *d*, *e*, *f*, *g*.

| | | |
|---|---|---|
| ACROSALENIA PUSTULATA. | | Forbes, Memoirs of the Geological Survey, Decade IV. Notes to pl. 3. |
| — | — | Forbes, in Morris's Catalogue of British Fossils, 2d ed., p. 70. |
| — | — | Desor, Synopsis des Échinides Fossiles, p. 143. |

Test hemispherical, depressed; ambulacral areas narrow, with two rows of small tubercles disposed alternately, rather wide apart, on the sides of the area; inter-ambulacral tubercles large at the equator, gradually diminishing towards the peristome, suddenly diminishing on the upper surface; miliary zone with four rows of granules; apical disc small, sur-anal plate composed of many pieces; mouth opening large; peristome nearly equally decagonal, notches wide; spines long, slender, tapering; stem flattened, ring prominent, striæ wide apart.

*Dimensions.*—Height, half an inch; transverse diameter, one inch.

As the size of this urchin varies very much, I have selected four specimens, from different localities in Northamptonshire, and have given their measurements in the following table—

| *Acrosalenia pustulata*, Forbes. | Height. | Diameter. | Mouth opening. | Apical disc. |
|---|---|---|---|---|
| | Inch. | Inch, | Inch. | Inch. |
| A. Large variety, Great Oolite . | $\frac{8}{10}$ | $1\frac{3}{10}$ | $\frac{6}{10}$ | $\frac{1}{2}$ |
| B. Yardley ditto, Great Oolite . | $\frac{6}{10}$ | $1\frac{1}{10}$ | $\frac{9}{20}$ | $\frac{4}{10}$ |
| C. Yardley ditto, Great Oolite . | $\frac{1}{2}$ | 1 | $\frac{4}{10}$ | $\frac{7}{20}$ |
| D. Oundle ditto, Forest Marble . | $\frac{3}{10}$ | $0\frac{11}{20}$ | $\frac{1}{4}$ | $\frac{1}{5}$ |

*Description.*—I have had much difficulty in making out the history of this species; and had it not been for the zeal, industry, and perseverance of my friend, the Rev. A. W. Griesbach, in obtaining, for the sake of comparison, a fine series of specimens from Oundle, Yardley, and Wollaston, Northamptonshire, I should have been unable to clear up the doubts. For several years I regarded the large, inflated forms of this urchin, with broad miliary zones, as granulated varieties of *Acrosalenia Wiltonii;* the only perceptible difference consisting in the size of the mouth opening, which is smaller in that species (Pl. XVI, fig. 3 *b*) than in *Acrosalenia pustulata* (Pl. XVI, fig. 2 *b*). The specimens which had been collected in Gloucestershire, Oxfordshire and Northamptonshire, were, on an average, about the size of the one figured in Pl. XVI, fig. 2, whilst Professor Forbes's type specimen was only half the size of our urchins; moreover, his diagnosis, always so correct in reference to the object he described, "areolis disjunctis, areâ centrali angustissimâ, bigranulatâ, granulis sparsis (diam. $\frac{1}{2}$ unc., alt. $\frac{1}{4}$ unc.)," did not agree with those I had hitherto collected, for their areolas were confluent, and the area centralis was broad, with four rows of granules. It occurred to me, therefore, that Professor Forbes's specimen, from the Forest Marble of Malmesbury, was possibly an immature form of the species. I, therefore, requested my friend, the Rev. A. W. Griesbach, to obtain specimens of the same age as those described by Professor Forbes, which he fortunately discovered, and these small urchins I found agreed very well with his diagnosis.

The ambulacral areas are narrow and straight, they have two rows of small tubercles, from eighteen to twenty in each row, disposed at some distance apart on the sides of the area, those at the base (fig. 2 *b*) are a little larger than those on the sides (fig. 2 *c*); a double series of granules takes the direction of the zigzag suture, and sends lateral branches between their small areolas, so that on the upper part of the area these granules are nearly as large as the small tubercles placed between them (fig. 2 *c*, *d*).

The poriferous zones are narrow, the pairs of pores are oblique, and the septa form moniliform elevations on the surface (fig. 2 *d*), which produce a bead-like line down the centre of the zone between the pores; and there are from eight to nine pairs of pores opposite each large tubercular plate (fig. 2 *d*).

The inter-ambulacral areas are nearly four times as wide as the ambulacral; they have eight plates in each column, of which the three equatorial pairs support large tubercles

(fig. 2 *c*); the three uppermost pairs of plates have mere rudimentary tubercles; the sudden diminution in size between the fifth and sixth forms a remarkable feature in the character of this species (fig. 2 *a*); at the base, the tubercles gradually diminish towards the peristome (fig. 2 *b*). In young shells, and in some adult ones, the miliary zone consists of two rows of granules; but, in other varieties, it is formed of four rows, closely set together, on the upper surface; the plates are covered with numerous equal-sized granules, among which the rudimentary tubercles are placed (fig. 2 *a*); the areolas of the three equatorial tubercles are circular and confluent, the uppermost has a distinct scrobicular circle of granules, but the others are confluent (fig. 2 *d*), and one row of granules separates the areolas from the poriferous zones; this description applies to the variety figured, but does not agree with others. The Rev. Mr. Griesbach, on this point, has made the following observations: "Among the very numerous specimens I found at Oundle, there is about an *equal* number of two dissimilarly constructed individuals. I pointed this out to you before (though you had seen it), and it is the same with the Wollaston specimens. When I found that age would not account for the difference, I was set to thinking about sex, making inquiries on this subject. I see from Professor Owen's lectures on the Invertebrate Animals, that the 'sexes are in distinct individuals in the Echinoids as in star-fishes;' and Professor Forbes, in Decade III, 'Mem. of the Geol. Survey,' accounts for the difference in form between some individuals of *Micraster coranguinum*, on the supposition that it may possibly be due to sex. This was all I wanted, to confirm an impression I had already entertained that the tall, ample form of this *Acrosalenia pustulata*, Forbes, with its broad granulated space between the primary tubercles, is the *female*, and the depressed one, with a narrow central area, the *male*. They are, without doubt, the same species; and I quite believe my sexual hypothesis to be true." As my excellent friend has carefully examined a greater number of specimens of this urchin than any other naturalist, it affords me much pleasure to record his explanation of a difficult problem, and to add that it affords a physiological reason for an admitted fact.

The apical disc is seldom preserved in this species (fig. 2 *a*); in one or two small specimens the genital and ocular plates are *in situ*, but only a portion of the sur-anal remains; the disc is pentagonal; the anterior and posterior pair of genital plates are shield-shaped; the right plate is the largest, and supports in its centre a spongy madreporiform body; the single plate is crescentic, and its body is absent, to give place to the vent; the three anterior oculars are heart-shaped, and the two posterior pairs are elongated, and form the sides of the anal aperture; the sur-anal is composed of many pieces; the three anterior, however, are alone *in situ*—one central, and two latero-posterior plates, behind these there was evidently a series to form the anterior boundary of the vent. The surface of all the plates is covered with numerous granules, similar to those on other parts of the test.

The base is flat; the mouth opening is large, nearly, but not quite, one half the width of the equatorial diameter; the peristome is decagonal, with wide notches (fig. 2 *b*); the ambulacral, however, being larger than the inter-ambulacral lobes.

The beautiful specimen, on a slab of Great Oolite from Yardley (fig. 2 *f*), was collected by Mr. Griesbach, and presented to me for this work; it shows the spines *in situ*. The primary spines are long, slender, and smooth; in length, once and two thirds the diameter of the test; they have a small, conical head, with a prominent milled ring (fig. 2 *e*); the stem tapers gently to the point, a transverse section shows it is somewhat triangular, with flattened or rounded angles; the surface, although apparently smooth, is covered with microscopic longitudinal lines. The secondary spines are small, stout, dagger-like bodies (fig. 2 *g*), with a flattened stem, and covered with longitudinal lines (fig. 2*).

*Affinities and differences.*—This species closely resembles *Acrosalenia Wiltonii*, but is distinguished by the following characters: it has larger equatorial tubercles, with more prominent bosses and wider areolas; the three superior tubercles more suddenly diminish in size; the miliary zone, even in the large granulated varieties, is narrower, the mouth is larger, the notches are wider and deeper, the test is more depressed, and the sides less inflated; but the most marked character resides in the mouth opening which is small, being about two fifths the diameter in *Acrosalenia Wiltonii*, and nearly one half the diameter in *Acrosalenia pustulata*.

*Locality and Stratigraphical position.*—This species has been collected by the Rev. A. W. Griesbach, from the Forest Marble at Oundle; the Great Oolite at Yardley; and Wollaston; and also from Strixton, Wimmington, Blisworth, and Kingsthorp, Northamptonshire. It was collected from the Great Oolite, near Woodstock, by Mr. Gavey; and from near Kiddington, Oxon, by Mr. Dominicke Brown, who kindly sent me a fine slab, with fourteen urchins on its surface, which he obtained from a Great Oolite quarry. In describing this specimen, Mr. Brown observes: "On examining the quarry where the *Cidaris* (*Acrosalenia pustulata*) is found, I can see at once the reason why the shells are not in a better state of preservation. The *Cidarites* appear only in a thin layer of rock not more than a foot or two below the surface, then comes a thick bed of marl, and below this the solid rock in which I occasionally find spines of *Cidaris*, but not often." This species has been found by Mr. Bravender, in the Great Oolite and Bradford Clay near Cirencester, and I have collected two specimens from the Forest Marble near Naunton Downs, which are both depressed and highly granulated varieties; I have seen separate portions of the test on slabs of the Forest Marble near Upper Cubberley, Gloucestershire, and in the Bradford Clay near the Tetbury-road Station, Great Western Railway, but I have never seen even a fragment of a specimen in the Great Oolite, of Minchinhampton.

ACROSALENIA WILTONII, *Wright*. Pl. XVI, fig. 3 *a*, *b*, *c*, *d*, *e*.

ACROSALENIA WILTONII. Wright, Annals and Magazine of Natural History, 2d series, vol. ix, p. 83, pl. 3, fig. 4 *a—e*.
— — Forbes, in Morris's Catalogue of British Fossils, 2d ed., p. 70.
— LAMARCKII. Desor, Synopsis des Échinides Fossiles, p. 141.

Test hemispherical, depressed, sometimes elevated; sides always tumid; ambulacral areas narrow, straight, with two rows of small perforated tubercles on the margins, set wide apart, and a miliary zone of three rows of fine granules between the marginal tubercles; inter-ambulacral areas four times the width of the ambulacral; ten tubercles in each row—of these the three middle pairs only are developed, the basal are small, and those at the upper surface rudimentary; miliary zone wide, composed of four rows of small granules in the middle, and six rows above; apical disc convex and prominent; sur-anal plate formed of two large and five small pieces; basal angle obtuse, from the tumidity of the sides; base concave; mouth opening small; peristome unequally decagonal.

*Dimensions.*—Height, half an inch; transverse diameter, one inch.

*Description.*—This beautiful little urchin has almost always a more or less elevated hemispherical test, which is rarely as much depressed as in fig. 3 *c*; the sides are tumid, and the base is concave; the ambulacral areas preserve a very uniform width throughout; two rows of small perforated tubercles placed wide apart occupy the sides of the area (fig. 3 *d*), with from eighteen to twenty in each row; the eight basal pairs are larger, and the lateral and dorsal pairs smaller, they are arranged closer together, and gradually diminish in size until they become quite microscopic (fig. 3 *d*); two or three rows of fine granules (fig. 3 *d*) form a miliary zone, which sends lateral branches to divide the small marginal tubercles.

The poriferous zones are narrow and undulated, the pores are unigeminal, except near the base, where they are trigeminal (fig. 3 *b*); opposite each of the large lateral plates there are eight pairs of pores (fig. 3 *d*).

The inter-ambulacral areas are four times as wide as the ambulacral; they have ten pairs of tubercles; the three basal pairs are small (fig. 3 *b*), gradually increasing in size from the peristome upwards, to blend in with the three lateral pairs, which are the largest (fig. 3 *c*, *d*); the eighth pair are suddenly smaller than the seventh pair, and the ninth and tenth pairs are quite rudimentary (fig. 3 *a*): the miliary zone is wide (fig. 3 *c*), and occupied by four or five rows of small close-set granules on the sides, increasing to six or seven rows on the upper surface; between the areolas and the poriferous zones there are likewise two

rows of granules: the bosses of the four middle pairs of tubercles are moderately large (fig. 3 *e*), they have small areolas, which are nearly divided from each other by horizontal lines of granules; in some they are absent, and the areolas are then confluent.

The apical disc (fig. 3 *a*) is seldom preserved; in one specimen however (Pl. XVII, fig. 5), it is seen to consist of an anterior and posterior pair of ovarial plates, and a single rudimentary ovarial; the sur-anal plate is composed of two unequal-sized pentagonal pieces, united with the anterior and posterior ovarials, and six or seven small pieces which form an arch, extending from the right to the left posterior ovarials, and completing the anterior wall of the anus (Pl. XVII, fig. 5); the posterior pair of ocular plates form the lateral, and the single ovarial the posterior boundary of the vent, which is transversely oblong, slightly excentral (fig. 3 *a*), and projects into the single inter-ambulacrum. The ocular plates are heart-shaped and of moderate size, and the eye-holes are very minute; the surface of all the discal elements is covered with small close-set granules (Pl. XVII, fig. 5).

The tumid sides are gently rounded towards the base, which is concave; the mouth opening is small, being less than two fifths the diameter of the test; the peristome is unequally decagonal, the ambulacral being one third larger than the interambulacral lobes.

The fragment of a primary spine shows that it was smooth and cylindrical, and, judging from its thickness, must have been long; the secondary spines are short and prickle-shaped, and are sculptured with fine longitudinal lines.

*Affinities and differences.*—This species so very closely resembles *Diadema* (*Acrosalenia*) *Lamarckii*, Desmoulins, that at one time I thought them identical, and stated as much in a letter to M. Desor; but from a more attentive study of the form, I now consider them distinct. *A. Wiltonii* has a more concave base, and a smaller mouth opening than any other form of the genus at present known. It differs from *A. pustulata* in having a wider miliary zone, a greater number of much smaller granules, a more concave base, and a smaller mouth opening; the same group of characters serve to distinguish it from *A. hemicidaroides* and *A. Lycettii*.

*Locality and Stratigraphical position.*—This urchin was collected many years ago by Dr. William Smith, from the Cornbrash of Wiltshire. My type specimens were found by Mr. William Buy, in the Cornbrash, near Sutton-Benger, Wilts, where it appears to be very rare, and is known as "the small-mouthed Cidaris." Mr. Bravender obtained it from the Bradford Clay, near Cirencester.

I dedicate this species to my esteemed friend, John Wilton, Esq., of Gloucester, with whom I have spent many hpapy days exploring the Natural History of different parts of Gloucestershire.

ACROSALENIA HEMICIDAROIDES, JUNIOR? *Wright.* Pl. XVI, fig. 4 *a*, *b*.

The small urchin, with spines attached, which forms the subject of fig. 4 *a*, *b*, was collected by Mr. William Buy, from the same bed of clay, between the Forest Marble and Cornbrash, from whence *Acrosalenia hemicidaroides* (Pl. XV, fig. 4) was obtained. At first, this specimen was thought to be distinct from that species, in consequence of the spines being more cylindrical; but as the test agrees with undeniable tests of *A. hemicidaroides*, about the same size, I am disposed to consider the difference in the form of the spines as depending on age. It may, however, hereafter be found to be a distinct species, although in the mean time, until better evidence is obtained, I regard it as the young of *A. hemicidaroides*, the materials at my disposal not enabling me to draw up a diagnosis. Fig. 4 *a* shows the upper surface of the test, with the primary spines *in situ*, the longest of which is once and two thirds the length of the diameter of the test; the head and milled ring agree in form with the same parts of the spine in *A. hemicidaroides*; the stem swells out a little in the middle, and tapers gently to the point; the sides are slightly flattened (fig. 4 *b*), and the surface is covered with fine, longitudinal lines: the secondary spines are short, stout, dagger-like bodies, on the surface of which the longitudinal lines are more distinctly marked, and the milled ring is proportionally more prominent than in the primaries.

*Locality and Stratigraphical position.*—From the band of clay between the Forest Marble and Cornbrash, near Malmesbury, where it was associated with *A. hemicidaroides* and numerous stems and fragments of *Pentacrinus*.

ACROSALENIA RADIATA, *Forbes*, nov. sp.

"A. ambulacris angustis, tuberculis parvis seriebus, duobus approximatis alternatis subdivergentibus dispositis; inter-ambulacrorum tuberculis numerosis regulariter graduatis, superne decrescentibus centro-lateralibus mediocribus, areolis disjunctis; areâ centrali angustâ pauci granulatâ, granulis sparsis.

"Diameter, seven twelfths of an inch; altitude, three tenths of an inch.

"It has affinities with *A. spinosa*, but differs in having the primary tubercles regularly diminishing instead of suddenly decreasing above." (Mus. Pract. Geol.)

*Locality.*—Collected by Mr. Lycett in the Great Oolite of Minchinhampton.

I have made the above extract entire from Professor Forbes's note on undescribed species of *Acrosalenia*, Decade IV, pl. 3, of the 'Memoirs of the Geological Survey.' After a careful comparison of the type specimen in the Museum of Practical Geology, in Jermyn Street, with a large series of *Acrosalenia spinosa*, I have in my collection, from the Great Oolite of Minchinhampton, and of Ranville, Calvados, and from the Cornbrash of Wiltshire, I can detect no persistent specific character in *A. radiata;* the upper inter-ambulacral tubercles are larger than in many specimens, but in others, the same gradual diminution observed in *A. radiata* prevails in a large series; in fact, the links between a sudden diminution and a gradual diminution are abundantly supplied; for these reasons I consider *A. radiata*, Forbes, as a synonym of *A. spinosa;* the structure of the apical disc, and of its single sur-anal plate, are the same in both.

ACROSALENIA ASPERA, *Agassiz.*

Professor M'Coy has entered this species in his list of Mesozoic Radiata,* contained in the Geological Collection of the University of Cambridge, giving as the localities of the species "Great Oolite, Minchinhampton, Inferior Oolite, Dundry." Having seen this specimen, I can state that I believe it to be a small *A. hemicidaroides* from Minchinhampton. The original *Acrosalenia aspera*, Agass., was found by M. Gressly in the Kimmeridge Clay of Banné, near Porrentruy, only a single specimen of which is known. I have never seen an urchin from Minchinhampton, nor Dundry, which resembled this Swiss species.

### D. *Species from the Coral Rag.*

ACROSALENIA DECORATA, *Haime.* Pl. XVII, fig. 1 *a, b, c, d, e, f, g, h, m.*

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|---|---|
| MILNIA DECORATA. | Haime, Annales des Sciences Naturelles, 3me série, tom. xii, Zoologie, 1849, pl. 2, figs. 1—3, p. 217. |
| ACROSALENIA DECORATA. | Wright, Annals and Magazine of Natural History, 2d series, vol. ix, p. 81, 1851. |
| — — | Forbes, Memoirs of the Geological Survey, Decade IV, pl. 3, 1852. |
| — — | Cotteau, Notes sur les Échinides de l'étage Kimméridgien du dép. l'Aube, Bulletin Soc. Géol. de France, 2d série, tom. xi, p. 355, 1854. |
| — — | Forbes, in Morris's Catalogue of British Fossils, 2d edit., p. 69, 1854. |
| — — | Desor, Synopsis des Échinides Fossiles, p. 143, 1856. |
| — — | Cotteau, Études sur les Échinides Fossiles, p. 322, 1856. |

* 'Annals and Magazine of Natural History,' 2d series, vol. ii, p. 419.

Test sub-pentagonal, depressed on the upper surface, concave at the base; ambulacral areas convex and prominent, the anterior and posterior pairs slightly sinuous, with two rows of small marginal tubercles, and the intermediate space filled with very small close-set granules; inter-ambulacral areas with from eight to ten tubercles in each row, the four equatorial tubercles very large, those on the upper surface very small; apical disc large, sur-anal plate composed of eight pieces; vent elongated and extremely excentral; base concave; mouth large; peristome equally decagonal; primary spines long, smooth, slender, and tapering; secondary spines small, hair-like.

*Dimensions.*—Height, four tenths of an inch; transverse diameter, nine tenths of an inch.

*Description.*—This elegant little urchin is remarkable among its congeners for its pentagonal form, arising from the flatness of the inter-ambulacral areas and the convexity and prominence of the ambulacral, and likewise for exhibiting in a most remarkable manner the bilateral symmetry of the Saleniadæ (fig. 1 *a*).

The ambulacral areas are one fourth the width of the inter-ambulacral; the anterior single area is quite straight, and the anterior and posterior pairs are sometimes slightly curved (fig. 1 *a*); the apices of the anterior pair curve gently backwards, and those of the posterior pair upwards and inwards (fig. 1 *a*); two rows of small secondary tubercles, from twenty to twenty-four in each row, occupy alternately the margins of the area (fig. 1 *d*), those at the base and circumference being much larger (fig. 1 *e*, *h*) than those on the upper surface (fig. 1 *d*); the intermediate space is occupied with four rows of very small close-set granules (fig. 1 *d*, *e*); both the tubercles and granules are extremely regular in their size and arrangement throughout the areas.

The poriferous zones are narrow and depressed, which increases the prominence of the ambulacra; the pores are unigeminal throughout, except just at the base, where they fall into indistinct ranks of threes (fig. 1 *b*, *h*); there are from eight to nine pairs of pores opposite each large tubercular plate (fig. 1 *e*); and the septa are slightly elevated on the surface.

The inter-ambulacral areas are four times as wide as the ambulacral (fig. 1 *c*, *e*), they are so much flattened that they form nearly straight lines at the circumference; each segment is composed of two rows of primary tubercles, about eleven in each row (fig. 1 *c*), which are unequally developed in different regions of the area; the four basal pairs (fig. 1 *b*) are small, the three equatorial pairs large (fig. 1 *c*), and the four dorsal pairs dwarfed and rudimentary (fig. 1 *d*, *e*); from the first to the eighth pair, the areolas are oval and confluent (fig. 1 *e*), whilst those on the upper surface are surrounded by clusters of granules (fig. 1 *d*); the miliary zone is broad, and composed at the equator of six rows of small close-set granules (fig. 1 *e*); on the upper surface the granules cover all the surface of the plates, the eight rudimentary tubercles appearing as only larger granules in their midst (fig. 1 *c*, *d*);

between the areolas and the poriferous zones there is another band of granulations, composed of three rows of larger granules, among which a few secondary tubercles rise at intervals (fig. 1 *e*), so that this species has wider granulated inter-tubercular bands than any other ACROSALENIA.

The large apical disc is oblong (fig. 1 *a*), with the vent excentrical, and placed so far back that it encroaches considerably on the single inter-ambulacrum (fig. 1 *g*); the two anterior pairs of genital plates are the largest (fig. 1 *g*), the posterior pair are smaller, and the single plate is extremely elongated; the body is absent, and the plate is represented by a thickened semi-lunar border with a reflected margin (fig. 1 *g*); this plate extends far down the single segment, and appears as if excavated for the passage of the vent (fig. 1 *a*); the ovarials are shield-shaped, and have the perforation for the ducts near their apex. The ocular plates (fig. 1 *g*) are small heart-shaped bodies, wedged between the genitals and the apices of the ambulacral areas, the three anterior ones are symmetrical, and the two posterior unsymmetrical, and slightly produced backwards; the eye-holes are lodged in the marginal sinus; the sur-anal plate is large (fig. 1 *f*), and composed of several pieces; namely, one central pentagonal plate, two smaller lateral rhomboidal plates behind the first, another pentagonal posterior to these two, and four smaller lateral pieces, making in all eight plates (fig. 1 *f*); these five small plates form the anterior wall of the opening for the vent, which occupies nearly the entire area of the single ovarial plate (fig. 1 *g*); the surface of the discal elements is covered with the same-sized delicate granules (fig. 1 *f*) as those which adorn the miliary zones (fig. 1 *d*).

The base is concave, the mouth opening large, one half the diameter of the body; the sides are tumid and rounded, so that the mouth appears to lie in a deep depression (fig. 1 *b*); the peristome is decagonal and nearly equal-lobed, the notches are wide and have the margin reflected all round the rim (fig. 1 *h*); the equatorial tubercles are extremely prominent, and their bosses are conoidal, with deeply crenulated summits (fig. 1 *i*).

The primary spines (fig. 1 *h*) are seen *in situ* in the specimens on the slab (fig. 1 *k*), some of them are one and a half the diameter of the test; they are sub-cylindrical, subulate, and, to the naked eye, appear smooth, but with the lens are seen to be finely striated; they are often slightly curved near their bases, and have their milled rings set obliquely; the head is small and conical, and the milling of the ring not well marked (fig. 1 *l*); a transverse section shows that the stem is slightly flattened (fig. 1 *l*).

The secondary spines (fig. 1 *m*) are very small, rather stouter in proportion to their length, and more distinctly striated than the primary spines (fig. 1 *m*): the head is larger, and the milled ring more prominent.

*Affinities and differences.*—This species differs so much from all its congeners, that it cannot be mistaken for either of them. In its general character it approaches *Acrosalenia spinosa*, but is distinguished from that species by its pentagonal form, the smallness of the superior inter-ambulacral tubercles, the concavity of the base, the width of the notches,

the equal size of the peristomal lobes, the magnitude of the apical disc, the compound character of the sur-anal plate, and the great excentricity of the vent; the fineness and abundance of the granulation which adorns the test fully entitles it to the name *decorata*.

*Locality and Stratigraphical position.*—I have collected this beautiful Acrosalenia from the seams of yellow clay which traverse the Coralline Oolite near Calne, Wilts, and from the limestone of the same locality associated with *Hemicidaris intermedia, Pseudodiadema mamillanum,* and *Echinobrissus scutatus.* The specimens in the Museum of Practical Geology were collected by the officers of the Geological Survey, from the Coral Rag at Steeple Ashton, Wilts, and near Abbotsbury Castle, Dorset; some of the specimens in the British Museum were obtained from the Coralline Oolite at Malton, Yorkshire.

It has been recently collected by M. Cotteau, "dans les couches Kimméridgiennes inférieures des environs de Bar-sur-Aube."*

*History.*—This species was first figured and described in the twelfth volume of the 'Annales des Sciences Naturelles,' by M. Jules Haime, as a remarkable urchin, "which he had seen in the collection of the British Museum, on the supposition that it exhibited characters not met with in any known genus of sea-urchins, and that it combined the anal arrangements of the Cassidulidæ with the usual characters of the Cidaridæ, an union of structures not hitherto observed." For this apparent anomaly, he proposed the genus *Milnia*, which he considered as the type of a new family, designated by him Pseudocidarides, and mistaking Malton, the locality from which this type specimen came, for Malta, he considered it as probably a tertiary species. Mr. Woodward, who was previously aware that the urchin thus erroneously described was an *Acrosalenia*, directed Professor Forbes's attention to the type specimen which was selected as the subject for plate 3, Decade IV, of the 'Memoirs of the Geological Survey,' where it is beautifully figured, with full details of structure. My lamented friend, knowing that I had collected this urchin in an excursion I made into Wiltshire, and being informed that I was engaged in writing a description of it in my memoirs, kindly communicated a proof impression of that plate to me: finding that it was deficient both in the anatomy of the apical disc and in the structure of the spines, I supplied Professor Forbes with the materials for both, which were then incorporated in his plate. It was fully described in my 'Memoirs on the Cidaridæ of the Oolites,' and afterwards by Professor Forbes in his description of plate 3, Decade IV, of the 'Memoirs of the Geological Survey of Great Britain.' As a foreign species, it was first found by M. Cotteau, and recorded in his 'Note sur les Échinides de l'étage Kimméridgien. du dép. l'Aube,' and afterwards was described in his valuable work on Fossil Echinoderms.†

* 'Bulletin Soc. Géol. de France,' 2e série, tom. xi, p. 355, 1854.

† Cotteau, 'Études sur les Échinides Fossiles du département de l'Yonne.'

# NOTES

## On Foreign Jurassic species of the genus ACROSALENIA nearly allied to British forms, but which have not yet been found in the English Oolites.

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Acrosalenia Lamarckii, *Desmoulins.* Syn. *Diadema Lamarckii,* Desmoulins, Tabl. Synon., p. 316.
*Hypodiadema Lamarckii,* Desor, Synop. Échin. Foss., tabl. 10, figs. 1—5.

Test small, inflated at the sides; ambulacra straight, with two marginal rows of small, distant, marginal tubercles, and a miliary zone of fine granulations between the rows; inter-ambulacral tubercles large at the equator, the three uppermost pairs rudimentary; miliary zone wide, composed of six rows of granules at the equator, which cover the whole surface of the plates on the upper surface; mouth opening small, base flat, peristome pentagonal, apical disc convex, sur-anal composed of several (six to eight) pieces.

*Dimensions.*—Height, half an inch; transverse diameter, nine tenths of an inch. Spines, according to M. Desor, "en forme de petits bâtons cylindriques, d'apparence lisse, à bouton haut."

*Formation.*—Cornbrash (Bathonien) de Marquise; abundant.

*Collections.*—In all English and Foreign public collections. My cabinet.

Acrosalenia Bouchardii, *Desor.* Synopsis des Échinides Fossiles, p. 142.

Test globular, depressed on the upper and under surfaces; ambulacra narrow, with two marginal rows of small tubercles, and a double row of granules between them; inter-ambulacral tubercles, nine in each row, diminishing gradually in size from the equator

towards the disc and peristome; miliary zone moderate in width, and composed of four rows of granules; mouth opening large, peristome decagonal; discal opening large.

*Dimensions.*—Height, eight tenths of an inch; transverse diameter, one inch and four tenths.

*Formation.*—Cornbrash (Bathonien) Marquise.

*Collections.*—British Museum, Neuchâtel Museum, M. Bouchard, M. Michelin, my cabinet. M. Desor states that this species is often ticketed in Continental collections by mistake, *Hemicidaris Luciensis*, d'Orbigny; the latter is altogether a different urchin.

Acrosalenia granulata, *Merian.* Syn. *Hemicidaris granulata*, Merian, in Agassiz's Catalogue raisonné, Annal. Sc. Naturelles, tome vi, p. 339, 3$^{me}$ série.

A small, depressed species. The ambulacral tubercles are so small that they resemble miliary granules; the tubercles of the inter-ambulacral areas are disposed at some distance apart.

*Formation.*—" Grande Oolite (Vesulien) de Gensingen (Argovie), avec les *Dysaster analis*, *Holectypus depressus*," &c. *Desor.*

*Collections.*—Museum Bâle, Collection M. Mæsch. Very rare.

Acrosalenia elegans, *Desor.* Synopsis des Échinides Fossiles, p. 143.

This species, according to M. Desor, resembles the preceding. It is larger, but has a small mouth opening, and the ambulacral tubercles are excessively small.

*Formation.*—" Grande Oolite (Vesulien) du Kornberg (Argovie), avec la précédente.

" *Collection.*—Mæsch." *Desor.*

Acrosalenia lens, *Desor*. Synopsis des Échinides Fossiles, p. 143.

According to M. Desor, this is the smallest species of the genus. It is about the size of a lentil, and is well characterised by its close-set inter-ambulacral tubercles, of which there are from nine to ten in a row.

*Formation*.—" Grande Oolite (Vesulien) de la cluse de Pfeffingen près Bâle.

" *Collection*.—Museum Bâle. Exemplaire unique." *Desor*.

Acrosalenia radians, *Agassiz*. Syn. *Hemicidaris radians*, Agassiz. Catalogue raisonné des Échinides, Annal. Sc. Naturelles, 3$^{me}$ série, tom. vi, p. 339.

Test hemispherical, depressed; ambulacra narrow, with two rows of small, prominent tubercles; inter-ambulacral tubercles, nine in a row, large at the equator, small above; miliary zone with two rows of granules in the middle; the median suture naked, and depressed at the upper surface; mouth opening large; peristome nearly equally decagonal, with wide notches; discal opening small.

*Formation*.—Kellovien de Vivoin, Courgains (Sarthe), Saint-Aubin (Calvados).

*Collections*.—MM. Michelin, Rouault; my cabinet. The type specimen kindly sent me by M. Michelin.

Acrosalenia interpunctata, *Quenstedt*. Handbuch der Petrefactenkunde, pl. 49, figs. 3 and 4.

Test small and much depressed; ambulacra very narrow; inter-ambulacra wide, with large, spaced-out tubercles; apical disc large; sur-anal plate single, smaller than the other plates; eight punctuations at the angles between the genitals, oculars, and sur-anal plate; five of these are at the inner angles of the eye-plates, and three around the circumference of the sur-anal plate; the five oviductal holes are very small.

*Formation.*—The White Jura ε of Nattheim = Coral Rag.

*Collection.*—Museum of Tübingen.

ACROSALENIA KŒNIGII, *Desmoulins.* Syn. *Diadema Kœnigii*, Desmoulins. Études sur les Échinides, Tabl. Synon., p. 312, No. 10.
*Hemicidaris Königii*, Agassiz. Catalog. raisonné des Échinides, Annal. Sc. Naturelles, 3me série, tome vi, p. 337.
*Hemicidaris Boloniensis*, Cotteau, in Desor's Synopsis des Échinides Fossiles, p. 53.

Test hemispherical, base flat, sides inflated; ambulacra narrow, straight, with two rows of small, marginal tubercles, and a double row of granules within; inter-ambulacra more than three times as wide as the ambulacra, with two rows of large primary tubercles, eight to nine in each row; the bosses of the tubercles large, with wide, oval areolas; miliary zone composed of two or three rows of granules; apical disc small, the right anterior genital plate supports a large, prominent, spongy madreporiform body; single genital plate small and crescentic; sur-anal compound, number of pieces unknown; mouth opening large; peristome unequally decagonal; primary spines long, cylindrical, and tapering.

The discovery of a portion of the sur-anal plate, *in situ*, added to the excentral position of the vent, and the absence of semi-tubercles from the base of the ambulacra, are my reasons for removing this urchin from the genus *Hemicidaris*, and placing it in *Acrosalenia*. I have, at the same time, retained M. Desmoulin's specific name.

*Dimensions.*—Height, one inch (?); transverse diameter, one inch and three quarters. Mr. Davidson's specimen exceeds these dimensions.

*Formation.*—Étage Kimméridgien, Ningles, near Boulogne-sur-Mer.

*Collections.*—British Museum, MM. Michelin, Desmoulins, Cotteau, Bouchard-Chantereaux, Davidson, my cabinet. The two largest specimens I possess were collected, and kindly given me, by M. Bouchard. The species is rare, these two specimens being all that eminent palæontologist collected in thirty years. Mr. Davidson has figured, in his original manuscript plates, a very beautiful specimen contained in his collection, which has the spines *in situ*.

ACROSALENIA WOODWARDI, *Wright*, nov. sp.

Test spheroidal, depressed; ambulacral areas narrow, with two rows of small tubercles placed very obliquely in the upper part, a single row of granules between them; inter-ambulacral areas four times as wide as the ambulacral, with few tubercles in each row; bosses large and rather prominent; tubercles widely perforated; apical disc moderate, four and a half lines in diameter; genital plates unequal, anterior pair largest; ocular plates small; sur-anal plate composed of several pieces.

Primary spines three inches and a quarter long, and one line and a half thick, some three inches long, and less than one line in their greatest thickness; tapering, and sometimes forked, at the extremity; very finely striated, or granulo-striated on the surface.

Secondary spines three lines long, slender, cylindrical, pointed, and striated.

*Dimensions.*—Height (?); transverse diameter, thirteen lines.

*Formation.*—Cornbrash? British?

*Collection.*—British Museum.

ACROSALENIA HUNTERI, *Wright*, nov. sp.

Test conoidal; ambulacral areas narrow, with two rows of small tubercles; inter-ambulacra with two rows of moderate-sized tubercles; test very much elevated; apical disc absent; its form, and excentral position, with the absence of semi-tubercles, at the base of the ambulacra, indicate its acrosalenian character.

*Formation.*—Unknown. I found this urchin in the celebrated John Hunter's collection. Not having access at present to the specimen, I am unable to give a more correct diagnosis of its specific characters.

*Collection.*—Hunterian Museum, Royal College of Surgeons, London.

## *Family* 6—ECHINOCONIDÆ.

Galérites (pars), *Desor.* 1842.
Echinonéides (pars), *Agassiz* and *Desor.* 1847.

This natural family includes urchins which have the mouth opening central, or sub-central, and the vent excentral. Their test is thin, with a circular or sub-pentagonal circumference; the upper surface in general is elevated, and sometimes even conical; the ambulacral areas are simple and lanceolate; the poriferous zones extend without interruption from the mouth to the apical disc, and the pores are unigeminal, except near the mouth, where they lie in triple oblique pairs. The inter-ambulacral areas are wide, the tubercles are small and perforated; they are arranged with more or less regularity on the plates, and supported on bosses which have either smooth or crenulated summits. In some genera, they form regular vertical and concentric rows, and the inter-tubercular surface is covered with small granules, which form complete circles round the base of the tubercles.

The mouth opening is circular, central, or sub-central, and the peristome is more or less divided by notches into ten lobes. The organs of mastication consist of five jaws, which appear to resemble those of the Echinidæ.

The anal opening is always large and excentral; it has an oblong or pyriform shape, and is either dorsal, marginal, infra-marginal, or basal, sometimes occupying the entire space between the mouth and the border.

The apical disc is mostly central and vertical, composed of five ovarial and five ocular plates; the right antero-lateral plate is very large, and extends backwards into the centre of the disc; it supports on its surface a prominent, spongy madreporiform body; the anterior and posterior pairs of ovarials are perforated, whilst the single posterior plate is imperforate; and the five small ocular plates are perforated near the margin.

The spines are small, short, conical appendages, with a smooth head, and having the stem covered with longitudinal microscopic lines.

I include in this extinct family the genera *Holectypus*, *Discoidea*, *Echinoconus*, *Pygaster*, and *Hyboclypus*. The *Holectypi* are found mostly in the Oolitic rocks, the *Discoideæ* and *Echinoconi* are true Cretaceous forms, the *Hyboclypi* are Oolitic, and the *Pygasters* are common to the Oolites and Chalk, although they had their greatest development during the Oolitic age. The oldest types are the *Pygasters* and *Hyboclypi*, which were created about the same time, at the commencement of the deposition of the basement beds of the Inferior Oolite.

## *Genus*—HOLECTYPUS, *Desor*, 1847.

Discoides (pars), Klein. 1734.
Echinites (pars), Leske. 1778.
Galerites (pars), Lamarck. 1816.
Discoidea (pars), Gray. 1835.

The genus *Holectypus* was established by M. Desor for the reception of those *Discoideæ* which are deprived of ribs, or projecting processes, on the inner wall of the test; the species referred to this group constitute one of the oldest types of the Echinoconidæ, and are met with chiefly in the Oolitic rocks. They form, according to the views of the late Professor Forbes, "a section or sub-genus of the *Galerites*, more valuable on account of their palæontological merits, and limited distribution in time, being in the main characteristic of the Oolitic period, than for the zoological importance of the characters of their organization, which are rather transitional than distinctive."*

The test is thin, circular, or sub-circular, more or less hemispherical, conical or sub-conical, always tumid at the sides, and flat or concave at the base.

The ambulacral areas are narrow, straight, and lanceolate, with six or eight rows of small tubercles, of which the marginal rows only extend from the base to the apex.

The poriferous zones are narrow, and the pores are unigeminal throughout.

The inter-ambulacral areas are three times the width of the ambulacral, the large pentagonal plates support numerous small, perforated tubercles, which are very regularly arranged in vertical and concentric rows (Pl. XVIII, fig. 1 *d*). They are raised on bosses with crenulated summits, and surrounded by ring-like areolas; numerous minute granules are scattered over the surface of the plates, and form circles around the tubercles (Pl. XVIII, fig. 1 *e*).

The mouth opening is circular, and situated in the centre of the base; the peristome is divided by obtuse notches into ten equal lobes (fig. 1 *b*). The organs of mastication consisted of five jaws, which are preserved *in situ* in the specimen figured at 1 *g*.

The anal opening is large, inferior, infra-marginal, rarely marginal, sometimes occupying the entire space between the mouth and the border.

The apical disc is nearly central and vertical, composed of five ovarial and five ocular plates; the right antero-lateral ovarial is much the largest, and extends into the centre of the disc; it supports a prominent, convex, madreporiform body; the anterior and posterior pairs of ovarials are perforated, whilst the single plate is imperforate; the five ocular plates are small, triangular bodies, with marginal perforations (fig. 1 *i*).

* 'Memoirs of the Geological Survey,' Decade III, pl. 6, *Holectypus hemisphæricus*.

The internal moulds of *Holectypus* want those depressions occasioned by ribs projecting from the inner walls of the test, which so well characterise *Discoidea*.

The spines are short, with a smooth head, and milled ring; and they have the surface sculptured with fine, longitudinal lines.

The *Holectypi* are distinguished from the *Echinoconi* by having a larger mouth and vent, a concave base, and a less-elevated dorsal surface; and from the *Discoideæ* in having tumid sides, a larger mouth and vent, and the absence of ribs from the internal wall of the test.

The small crenulated tubercles, and basal vent, with the absence of any aperture in the upper surface of the inter-ambulacrum, distinguishes the *Holectypi* from the *Pygasters;* and the want of a longitudinal valley in the inter-ambulacrum separates them from the *Hyboclypi*.

The *Holectypi* are abundant chiefly in the Oolitic rocks; two of the species are found in the Neocomian and the Chalk. They make their first appearance in the Inferior Oolite, in the zone of the *Ammonites Parkinsoni*, Sow.

A. *Species from the Inferior Oolite.* = 10^e *Étage Bajocien*, D'Orbigny.

HOLECTYPUS DEPRESSUS, *Leske.* Pl. XVIII, fig. 1 *a, b, c, d, e, f, g, h, i.*

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| | Jacob. a Melle de Echinitis Wagricis, tab. 1, fig. 2, 1718. |
| | Kundman, Rariora Naturæ, tab. 5, fig. 12, 1737. |
| | Brückner, Merkwürdigkeiten der Landschaft. Basel, tab. 22, figs. G, H, 1748-63. |
| | Van Phelsum, Brief. de Gewelvslekken of Zee-egelen, p. 31, No. 16 (*Egelsteen tienband plattop*), 1774. |
| | Knorr, Petrefactions, vol. ii, tab. E, ii, figs. 6, 7, 1775-78. |
| | Favanne, pl. 67, figs. 1, 2. |
| ECHINITES DEPRESSUS. | Leske, Additamenta ad Kleinii Echinodermata, p. 164, pl. 41, figs. 5, 6, 1768. |
| ECHINUS DEPRESSUS. | Linné, Systema Naturæ, Gmelin, p. 3182. |
| GALERITES DEPRESSUS. | Lamarck, Animaux sans Vertèbres, tom. iii, p. 21, 1816. |
| — — | Deslongchamps, Enc., tom. ii, p. 432; Encyl. Méthod., tab. 152, figs. 7, 8. |
| — — | Defrance, Dict. des Sciences Naturelles, tome xviii, p. 86, 1820. |
| ECHINITES ORIFICIATUS. | Schlotheim, Jahrb., 1813; Petrefactenkunde, p. 317, 1822. |
| GALERITES DEPRESSUS. | Goldfuss, Petrefacta Germaniæ, Band i, p. 129, tabl. 41, fig. 3, 1826. |
| — — | Phillips, Geology of Yorkshire, tab. 7, fig. 4, 1829. |
| — — | De Blainville, Zoophytologie, p. 204, 1830. |
| — DEPRESSA. | Leonhard and Bronn, Jahrb., 1834, p. 135. |
| — — | Desmoulins, Études sur les Échinides, p. 254, No. 6, 1835. |
| — DEPRESSUS. | Grateloup, Mémoire sur les oursins Fossiles (Dax), p. 56, No. 9, 1836. |

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| Galerites radiatus. | Valenciennes, Encyclopéd. Methodique, tab. 153, figs. 1, 2 (Explication des Planches). |
| — depressa. | Koch and Dunker ? Norddeutschen Oolithgebildes, p. 40, tab. 4, fig. 2 *a*, *b*, 1837. |
| Holectypus depressus. | Bronn and Römer, Lethæa Geognostica, 3$^{tte}$ Auflage, Band ii, p. 148, tab. 17, fig. 5 *a*, *b*, 1851. |
| Discoidea depressa. | Agassiz, Prodromus, p. 86, 1837. |
| — — | Agassiz, Échinodermes Foss. de la Suisse, part i, p. 88, tab. 13, figs. 7—13, 1839. |
| — — | Desor, Monographie des Galérites, p. 65, tab. 10, figs. 4—12, 1842. |
| Holectypus depressus. | Desor, Catalogue raisonné, Ann. des Sc. Nat., 3$^{me}$ série, tom. vii, p. 145, 1847. |
| — — | Albin Gras, Oursins Fossiles du département de l'Isère, p. 41, 1848. |
| — — | Wright, Annals and Magazine of Natural History, 2d series, vol. ix, p. 94, 1851. |
| — — | Forbes, in Morris's Catalogue of British Fossils, 2d edit., p. 82, 1854. |
| | Desor, Synopsis des Échinides Fossiles, p. 169, 1857. |

Test thin, hemispherical, sometimes conoidal, more or less depressed; circumference circular, or sub-pentagonal, and slightly contracted posteriorly; base flat, or a little concave; mouth central; peristome nearly equally decagonal, with reflected margin; anal opening large, pyriform, occupying nearly all the space between the mouth and the border; ambulacral areas lancet-shaped, with from six to eight rows of tubercles at the circumference, arranged in two oblique rows; inter-ambulacral areas with from sixteen to twenty rows of tubercles, which form a single row on the centro-sutural half of each plate, and two or three rows on the zonal half of the same; apical disc small, four genital plates nearly equal sized, the right antero-lateral large, with the madreporiform body projecting into the centre of the disc.

*Dimensions.—Cornbrash specimen.* Height, nine tenths of an inch; transverse diameter, two inches and two tenths of an inch; antero-posterior diameter, two inches and two tenths.

*Inferior Oolite specimen.* Height, seven tenths of an inch; transverse diameter, one inch and a quarter; antero-posterior diameter, one inch and seven tenths.

*Description.*—This is one of the most ubiquitous Echinites of the Oolitic rocks, and as its synonymy shows, has been long known to naturalists. In different formations it attains various degrees of development, being small in the Inferior Oolite, but large in the Cornbrash, as shown by the measurement of the specimens from these two stages.

The form is sub-conoidal, or more or less depressed; the circumference is circular, or sub-pentagonal, with the postero-lateral border a little compressed, and the single

inter-ambulacrum slightly produced and truncated (fig. 1 *a*, *b*). The ambulacral areas are one third the width of the inter-ambulacral; they have a lanceolate form, and taper gradually from the border to the disc; at the circumference there are eight rows of tubercles, which are disposed so as to form double oblique rows, thus— (fig. 1 *d*). In the upper part of the areas the inner rows disappear, and the test is depressed in the line of the median suture (fig. 1 *a*).

The inter-ambulacral areas are three times as wide as the ambulacral, each plate supports a number of tubercles, one row represents the principal range, and extends from the peristome to the disc, and the tubercles of this row are a little larger than the others on the upper surface, but nearly of the same size on the sides and base. Between this primary row and the centro-suture, the tubercles are arranged in a single line on the same plane; but between it and the poriferous zones they form three superimposed rows (fig. 1 *d*), so that the zonal side of the plates contains many more tubercles than the central half. The tubercles are surrounded by sunken areolas; they have crenulated bosses and perforated summits, and the intermediate surface of the plates is covered with a fine, abundant, miliary granulation. The tubercles at the base are much larger, they have deeper areolas, and are all disposed in single, concentric rows (fig. 1 *b*).

The poriferous zones are extremely narrow, and the pores are unigeminal throughout. The septa are elevated above the surface, and form a moniliform line between the pores (fig. 1 *d*), of which there are eight pairs opposite each inter-ambulacral plate.

The apical disc is well preserved in many of our specimens. Fig. 1 *i*, is an accurate drawing of this part (fig. 1 *a*). The anterior and posterior pairs of genital plates are perforated, but the single posterior plate is imperforate; the antero-lateral plate is very large, and extends into the centre of the disc; it supports a prominent, spongy, madreporiform body, which forms the summit of the test, and occupies the centre of the disc; not, however, as a new element introduced into the centre of the genital circle, but formed simply by the development of the right antero-lateral plate. The ocular plates are small, heart-shaped bodies, inserted between the genitals (fig. 1 *i*), with the eye-holes perforated near their margin (fig. 1 *i*); all the discal plates are covered with small tubercles, similar to those which form the miliary granulation. In M. Desor's 'Monograph on the Galerites,' tab. 10, fig. 7 *a*, the eye-holes are represented as marginal, and the madreporiform body is figured and described as distinct from the genital plates. It is probable that the imperfection of his specimens led the learned author into these errors, which we have now the pleasure of correcting by our better examples. The under surface is slightly concave, the mouth opening is central, and upwards of one third the diameter of the test (fig. 1 *b*). The peristome is nearly equally decagonal, and the notches are wide, with reflected margins. In one specimen, collected by Mr. William Buy, from the Forest Marble of Wiltshire, the jaws are preserved *in situ* (fig. 1 *g*).

Although the structure of the peristome in the Echinoconidæ led us to infer the existence of jaws in the entire family, still we had only feeble traces of them in *Echinoconus albo-galerus*, Klein, and *Pygaster umbrella*, Agass. Our discovery of these organs in *Holectypus depressus*, Leske, is a fact new to science; each jaw consists of two slender branches united near the apex, and supports a long, slender, prismatic tooth (fig. 1 *g*).

The anal opening is large and pyriform, with the apex directed towards the mouth; it occupies nearly all the space between the mouth and the border, and is therefore situated entirely at the base of the shell (fig. 1 *b*); the direction of the apex of the vent inwards, and its basal position, form important diagnostic characters, by which this species is clearly distinguished from its congeners. The tubercles situated at the base, are much larger and more fully developed than those on the upper surface (fig. 1 *f*), but instead of having a circle of granules around the areolas, they are separated laterally from each other by sharp elevations of the test, the upper and under sides of the areolas being bounded by crescents of granules (fig. 1 *f*).

Many spines are preserved *in situ* on the shell (fig. 1 *g*); they have a long, conical head, with a prominent ring, and a slender, tapering stem, which is sculptured with numerous longitudinal lines (fig. 1 *h*); the apex is blunted. Besides these primary spines, which were articulated with the largest tubercles, I find the miliary granulation at the base likewise possessed fine, hair-like spines, as they are observed in connection with their granules among the larger spines at the under surface (fig. 1 *g*).

*Affinities and differences.*—*Holectypus depressus*, Leske, may be regarded as the best type of this genus. It is distinguished from *H. hemisphæricus*, Desor, by its more depressed form, basal vent, and more acute marginal fold. The apex of the pyriform anal opening is directed towards the mouth, whilst in *H. hemisphæricus*, it is just the reverse.

It is distinguished from *H. oblongus*, Wright, by the form of the test, which is circular or sub-pentagonal, whereas in that Coral Rag species it has an oblong shape; the tubercles on a portion of the inter-ambulacral plates form a single line of tubercles, whilst in *H. oblongus* they are disposed in double lines on the same plate (fig. 3 *d*).

*Locality and Stratigraphical position.*—This urchin is found for the first time in the Upper Ragstones of the Inferior Oolite, in the zone of *Ammonites Parkinsoni*, Sowerby. I have collected it from the Trigonia Grit, wherever that bed is present, along the whole range of the Cotteswold Hills, as at Dundry, Wotton-under-Edge, Stinchcombe, Rodborough, Coopers, Birdlip, Shurdington, Leckhampton, and Sudeley Hills; and at Hampen, Naunton, and Stow-in-the-Wold, likewise in the Cornbrash near the Kemble Tunnel, and in the neighbourhood of Cirencester, Gloucestershire. It is found rarely in the Cornbrash near Chippenham, but abundantly in that formation near Trowbridge, Wilts, whence I have a very fine series of large specimens in the finest preservation, collected by Mr. Macniel.

The Rev. A. W. Griesbach has collected the finest specimens I have seen in the Cornbrash near Rushden, Northamptonshire; the beautiful specimens fig. 1, *a*, and *b*, are two of these, kindly presented for this work. The Cornbrash specimens are always larger and finer than those collected from the Inferior Oolite. Mr. Gavey obtained it from the Cornbrash near Woodstock, Oxon.; and it is found abundantly at Scarborough, in the Cornbrash near the Castle Hill.

Holectypus hemisphæricus, *Agassiz*. Pl. XVIII, fig. 2 *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*.

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|---|---|
| Discoidea hemisphærica. | Agassiz, Catalogus Systematicus, p. 7. |
| — — | Desor, Monographie des Galérites, pl. 8, figs. 4—7, p. 71. |
| Holectypus hemisphæricus. | Agassiz et Desor, Catalogue raisonné des Échinides, Annal. des Sc. Nat., 3me série, vol. vii, p. 146. |
| Galerites hemisphæricus. | Forbes, Memoirs of the Geological Survey, Decade III, pl. 6. |
| Discoidea marginalis. | M'Coy, Annals and Magazine of Natural History, 2d ser., vol. ii, p. 413. |
| Holectypus Devauxianus. | Cotteau, Études sur les Échinides Fossiles, pl. 2, figs. 7—9, p. 46. |
| — hemisphæricus. | Wright, Annals and Magazine of Natural History, 2d ser., vol. ix, p. 96. |
| — — | Forbes, in Morris's Catalogue of British Fossils, 2d edit., p. 82. |
| — — | Desor, Synopsis des Échinides Fossiles, p. 172. |

Test hemispherical, more or less depressed; sides tumid; margin rounded; posterior half of the test longer than the anterior; single inter-ambulacrum slightly produced; anal opening marginal, large, and pyriform, with the apex directed upwards; base nearly flat; mouth opening small.

*Dimensions.*—Height, eight tenths of an inch; transverse diameter, one inch; antero-posterior diameter, one inch and a quarter.

*Description.*—The marginal vent of this urchin sufficiently distinguishes it from its congeners. It is very abundant in some localities, but rare in others; it appears to have had a very limited life in time, having been hitherto only found in a marly vein, about an inch in thickness, which traverses the Trigonia bed of the Inferior Oolite, in the zone of *Ammonites Parkinsoni*, Sow. I have examined many hundreds of specimens of this Echinite, which all came from the same bed.

M. Desor has given a very good figure of this species in his 'Monograph on the Galerites,' which appears to have been the small conical variety.

Professor Forbes has given most beautiful figures, with full details, of *Holectypus hemisphæricus*, in Decade III, pl. 6, which leave nothing more to be desired.

The general outline of this urchin is sub-hemispherical, but it is more or less convex in different individuals; some varieties are depressed, and others are conoidal, but few specimens are regularly convex; most commonly they have a slight obliquity, from the test in a majority of specimens being slightly elongated in the antero-posterior diameter, and declining on the side towards the vent; the vertex is therefore not quite central, and the apical disc is nearer the anterior than the posterior border; the sides are a little tumid, and the margin is gently rounded thereby.

The ambulacral areas are about one third the width of the inter-ambulacral; from the border to the disc they are quite conical, and taper gradually between these two points; there are six rows of tubercles at the margin, which gradually diminish to four and two on the upper surface; the two outer rows alone extend from the peristome to the disc; each pair of the small, narrow ambulacral plates (fig. 2 *d*) supports one tubercle, which occupies the same relative position thereon on every fourth plate, so that the areas are adorned at their widest part with six rows of tubercles, arranged obliquely in V-shaped lines, thus— ⋮⋮⋮⋮⋮⋮ In a specimen one inch and a quarter in diameter I counted one hundred and twenty plates in each column. The poriferous zones are narrow, the pores are strictly unigeminal, and there are from four to five pairs of pores opposite each inter-ambulacral plate.

The inter-ambulacral areas are rather more than three times the width of the ambulacral (fig. 2 *a*); the number of plates in each column varies with the age of the urchin; in the one before me there are thirty-two plates; those on the sides are slightly bent upwards in the middle, whilst the basal plates are nearly straight; each plate supports one or two tiers of tubercles, the number and arrangement of which varies exceedingly in different individuals; fig. 2 *d* shows a common distribution of the tubercles on the plates near the margin; besides these spinigerous tubercles, the entire surface of the plates is covered with a fine, close-set, miliary granulation, from the midst of which the tubercles appear to arise; near the margin, in one specimen there are sixteen tubercles abreast in one inter-ambulacral area; the tubercles become crowded towards the margin; they increase in size at the base (fig. 2 *h*), but the number on the plates in this region is inconsiderable. The perforated tubercles are raised on crenulated bosses, which are surrounded by a sunken areolas; at the base many of these are encircled by perforated granules (fig. 2 *i*).

The apical disc is small (fig. 2 *a*), and formed of five genital, and five ocular plates; the pairs of genital plates are shield-shaped and perforated; the single plate is imperforate; the right anterior genital plate is the largest, and extends into the centre of the disc, supporting on its surface the spongy madreporiform body. The ocular plates

are small pentagonal bodies, wedged between the angles formed by the ovarials and the summits of the ambulacra; the eye-holes are large, and pierced near the lower border (fig. 2 *e*), their axis having a slanting direction upwards. The surface of all the discal elements is covered with close-set, miliary granules, similar to those on the surface of the plates.

The vent occupies the margin of the single inter-ambulacrum (fig. 2 *c*); its form is pyriform, with the rounded base extending half way into the ventral surface (fig. 2 *b*), and its apex directed upwards towards the apical disc (fig. 2 *c, g*). The widest or basal portion of the vent occupies the outer half of the space between the peristome and the margin (fig. 2 *b*), and the apex extends one fourth of the distance between the base and the disc (fig. 2 *g*), but these proportions vary considerably in every individual I have examined; the marginal opening for the vent, however, is a constant diagnostic character of the species.

The mouth opening is small, being rather more than one fourth the diameter of the test; the peristome is equally decagonal, the notches are wide and rounded, with the margin reflected (fig. 2 *b*); the base is concave; and the oral opening lies in a central depression of the ventral surface.

Among the many hundreds of specimens which I have examined, the specific characters above described are retained in all with remarkable persistence; still there are certain points, such as differences in the amount of convexity, the proportion between the height and the breadth, the distance between the vent and the mouth, and the number and regularity of the tubercles, which vary in certain specimens; they may all, however, be reduced to three principal types.

Var. α. *Hemisphæricus*, represented by our fig. 2 *a, b, c*.

Var. β. *Conicus*, represented by our fig. 2 *g*.

Var. γ. *Depressus*, with the upper surface much depressed, but the vent marginal.

In the following table I have embodied the comparative dimensions of six specimens from six different localities in Dorsetshire:

| No. | Locality. | Height. | Breadth. | Anus to Mouth. |
|---|---|---|---|---|
| | | Inch. | Inch. | Inch. |
| 1 | Stoke Knaps | $\frac{5}{12}$ | 1 | $\frac{3}{12}$ |
| 2 | Loders | $\frac{1}{12}$ | $1\frac{1}{12}$ | $\frac{2}{12}$ |
| 3 | Crewkerne | $\frac{8}{12}$ | $1\frac{1}{12}$ | $\frac{2}{12}$ |
| 4 | Castle Cary | $\frac{7}{12}$ | $\frac{8}{12}$ | $\frac{3}{12}$ |
| 5 | Bridport Harbour | $\frac{5}{12}$ | $\frac{8}{12}$ | $\frac{3}{12}$ |
| 6 | Walditch | $\frac{9}{12}$ | $1\frac{4}{12}$ | $\frac{4}{12}$ |

*Affinities and differences.*—The tumid sides, convex upper surface, and marginal vent of *Holectypus hemisphæricus* serve to distinguish this species from all its congeners, and by these characters it is readily separated from all other *Holectypi.*

*Locality and Stratigraphical position.*—In the stratigraphical position of this species, I am at issue with the statement made by Professor Forbes, who remarks: "During the examination of the Inferior Oolite strata in Somersetshire and Dorsetshire, by the members of the Geological Survey, this species was collected abundantly, chiefly in the sands of the Inferior Oolite, in numerous places, associated in most instances with *Dysaster ringens,* and often *Dysaster bicordatus.*" The following is a list of the principal localities in which it was found: Hazelbury, Crewkerne, Lyttelton Hill, near Cadbury, Whatley, near Frome, Little Windsor, Loders (top beds), Stoke Knaps, Greenland, Compton Pauncefoot (bottom beds), Pilcombe, Bruton, Shipton Gorge, Burton Bradstock, and near Burton Castle (top beds), Bridport Harbour, Chideock Hill, Mapperton, West Swillets, Beaminster."*

I have never seen this urchin lower than the marly vein which traverses the upper ragstones in the zone of *Ammonites Parkinsoni,* Sow.; where I have found it with *Cidaris Bouchardii,* Wright; *Stomechinus bigranularis,* Lamarck; *Clypeus Agassizii,* Wright; *Clypeus altus,* M'Coy; *Hypoclypus gibberulus,* Agassiz; *Ammonites subradiatus,* Sow.; *Ammonites Parkinsoni,* Sow.; *Terebratula sphæroidalis,* Sow.; *Rhynchonella plicatella,* Sow. It is true, that in many of the localities in the above list, the ragstones rest on the sands of the Inferior Oolite; a collector, therefore, might readily obtain specimens from the sands which had dropped out of the marly seam, and thereby conclude that they belonged to that formation; but I have shown† that the so-called sands of the Inferior Oolite belong to the upper region of the Upper Lias, to the zone of *Ammonites Jurensis,* Zieten, and *Ammonites variabilis,* d'Orbig., and that, as far as we at present know, urchins have not been found in this bed.

I have collected *Holectypus hemisphæricus* from the Trigonia grit at Shurdington, Leckhampton, and Hampen, in Gloucestershire, associated with *Pedina rotata,* Wright; *Holectypus depressus,* Leske; *Echinobrissus clunicularis,* Llhwyd; *Echinobrissus Hugii,* Agass.; *Clypeus Plottii,* Klein; *Ammonites Parkinsoni,* Sow.; and *Terebratula globata,* Sow.

### B. *Species from the Coral Rag* = 14$^{e}$ *Étage Corallien,* d'Orbigny.

HOLECTYPUS OBLONGUS, *Wright,* nov. sp. Pl. XVIII, fig. 3 *a, b, c, d.*

Test oblong, inflated at the sides, depressed at the upper surface; anterior half of the test shorter, broader, and rounder than the posterior half, which becomes narrow,

* 'Memoirs of the Geological Survey,' Decade III, pl. 6, pp. 4, 5.

† 'Quarterly Journal of the Geological Society,' vol. xii, p. 292.

and has the single inter-ambulacrum produced; anal opening at the base; tubercles on the upper surface very small and indistinct; those at the base and margin moderately large; mouth opening concealed.

*Dimensions.*—Height, seven tenths of an inch; transverse diameter, one inch and a quarter; antero-posterior diameter, one inch and four tenths.

*Description.*—The few specimens of this urchin I have examined were not in good preservation, the surface of the test having been more or less rubbed in them all, so much so, that a detailed description, with the materials at my disposal, is at present impossible.

The test is oblong, with tumid sides; it is rounded before, contracted and elongated behind, so that the anterior half is an eighth of an inch shorter than the posterior half, when measured from the disc to the border (fig. 3 *a*).

The ambulacral areas are one third the width of the inter-ambulacral; they have six rows of small tubercles, which form V-shaped lines throughout the area; the poriferous zones are narrow; and there are five pairs of pores opposite each inter-ambulacral plate (fig. 3 *d*).

The inter-ambulacral spaces are of equal width, and three times as broad as the ambulacral (fig. 3 *a*); from the disc to the border there are twenty plates in each column, which are all slightly bent in the middle; on some of the plates there is only one row of tubercles, but in the others there are two rows, arranged as in fig. 3 *d*, which are small and indistinct from friction; the basal tubercles of both areas are larger, and they are arranged in single concentric lines.

The base is much concealed in all the specimens I have seen; the mouth is entirely, the vent partially so, in those before me; the anal opening appears to be a large aperture, situated between the mouth and the border, but encroaching a little upon the latter; and has the apex directed towards the mouth.

The apical disc is small, vertical, and excentral, being nearer the anterior than the posterior border; the ovarial plates are small, with the exception of the right antero-lateral, which is nearly twice as large as the others, and supports an oblong, madreporiform body; the ocular plates are very small, and perforated near their border.

*Affinities and differences.*—This species very much resembles *H. depressus*, Leske; but it has a more oblong form, more tumid sides, and the anal opening is nearer the border than in that species; by the smallness of the tubercles it is distinguished from *H. corallinus*, d'Orbigny, and by the arrangement of the tubercles on the plates from *H. depressus*; the basal position of the anus separates it from *H. hemisphæricus*, Agassiz. The imperfect condition of all the specimens I have seen renders a more critical comparison at present impossible.

*Locality and Stratigraphical position.*—The four or five specimens I have examined were all collected from the Coralline Oolite of Malton, Yorkshire.

# NOTES

## On Foreign Jurassic species of the genus HOLECTYPUS, nearly allied to British forms, but which have not yet been found in the English Oolites.

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Holectypus planus, *Desor*. Monogr. des Galérites, tab. 9, figs. 1—3.

Test small, flat, pentagonal; dorsal surface convex, base concave; tubercles on the upper surface small, about ten rows in the inter-ambulacra at the circumference, basal tubercles much larger; mouth small, central; vent small, occupies only half the space between the mouth and the border.

*Dimensions.*—Height, seven twentieths of an inch; transverse diameter, three quarters of an inch.

*Formation.*—Oxford Clay, Vaches-Noires, Normandy.

*Collections.*—M. Michelin, my Cabinet. Very rare.

Holectypus Mandelslohi, *Desor*. Monogr. des Galérites, tab. 9, figs. 14—16.

Test sub-conical; tubercles small on the upper surface, large at the base, arranged in vertical and horizontal rows; mouth small; vent at the base nearly as wide as the mouth; miliary granulation abundant, and close-set.

*Dimensions.*—Height, nine twentieths of an inch; transverse diameter, eight tenths of an inch.

*Formation.*—Corallien inférieur (terrain à chailles), Albe Wurtembergeoise, Lusberg (Canton du Soleure). "Argovien (avec *Dysaster granulosus*) du Randen de Birmansdorf, de Baden." *Desor*.

*Collections.*—Count Mandelslohe, M. Gressly, M. Moesch. Mus. Bâle, Mus. Neuchâtel.

HOLECTYPUS PUNCTULATUS, *Desor.* Monogr. des Galérites, tab. 9, figs. 17—19.

Test hemispherical, sides tumid; tubercles form regular, horizontal, and vertical series, ten rows in the inter-ambulacra, and six rows in the ambulacra, which are much more developed at the base; mouth small, vent large, between that opening and the border. This species has many important affinities with the preceding, and is only distinguished from it, according to M. Desor, by having fewer tubercles, which are arranged with greater regularity.

*Dimensions.*—Height, four tenths of an inch; transverse diameter, eight tenths of an inch.

*Formation.*—Corallien inférieur de Largue (Canton de Berne), Dettingen, Württemberg, Mont-de-Bregille (près Besançon). Oxfordien de Chambery. *Renevier.*

*Collections.*—MM. Gressly, Parandier; Count Mandelslohe. Abundant.

HOLECTYPUS CORALLINUS, *d'Orbig.* Cotteau, Études sur les Échinides Foss., pl. 32, figs. 1—8.

Test sub-pentagonal, sub-conical above, flat or sub-concave below; tubercles disposed in regular, vertical, and concentric series, a single longitudinal row on each plate, small and few in number on the upper surface, large and numerous at the circumference and base, about twelve in the widest part of the inter-ambulacra. Granules unequally scattered on the surface of the plates. Mouth central, peristome deeply notched; vent large, elliptical, between the mouth and the border.

*Dimensions.*—Height, eleven twentieths of an inch; transverse diameter, one inch and a quarter.

*Formation.*—Corallien 14$^{e}$ étage, d'Orbig.; Druyes, Châtel-Censoir (Yonne). Kimméridgien 15$^{e}$ étage. Pointe-du-Ché (Yonne). *Cotteau.*

*Collections.*—MM. Cotteau, d'Orbigny. Abundant.

HOLECTYPUS ARENATUS, *Desor*. Monogr. des Galérites, tab. 9, figs. 11—13.

The tubercles, although very numerous, are disposed with great regularity; the miliary granules form continuous horizontal series; mouth opening small, with rows of oblong granules near the peristome; in its general form it resembles *H. punctulatus*, Des., and *H. Mandelslohi*, Des., and is distinguished from these species only when the details of the test are well preserved.

*Dimensions.*—Height, four tenths of an inch; transverse diameter, eight tenths of an inch.

*Formation.*—Oxfordien du Canton de Soleure. Very rare.

*Collection.*—M. Gressly.

HOLECTYPUS SPECIOSUS, *Münster*. Syn. *Galerites speciosus*, Goldfuss, Petref. German., tab. 41, fig. 5 *a*, *b*.
*Discoidea speciosa*, Agass., Echin. Foss. Suisse, tab. 6, fig. 16. (*non.*)
— — Desor, Monogr. des Galérites, tab. 10, fig. 13. (*non.*)

Test large, depressed; the plates of the ambulacral and inter-ambulacral areas very narrow in proportion to their length; tubercles on the upper surface small and irregularly disposed; tubercles at the base larger, and arranged in double horizontal rows, closely placed together on each plate; mouth opening small, peristome decagonal; anal opening large, pyriform, occupying half the space between the border and the peristome.

*Dimensions.*—Height, one inch and a half; transverse diameter, three inches and three quarters.

*Formation.*—Kimmeridge Clay of the valley de La Birse, near Lanfon (Greifel); Upper Stage of the Calcaire Jurassique de Heidenheim (Würtemberg).

*Collections.*—Count Münster, M. Gressly.

Holectypus inflatus, *Agassiz*. Syn. *Discoidea inflata*, Agassiz, Échinoderm. Foss. Suisse, tab. 6, figs. 4—6.
— — Desor, Monogr. des Galérites, tab. 9, figs. 7—10.

Test thin, small, and depressed, with tumid, inflated sides; tubercles small, numerous, twelve rows in the inter-ambulacra, and four in the ambulacra; miliary granules do not form horizontal series; mouth opening small and decagonal; anal opening very large and pyriform, extending from the peristome to the border, with the apex directed towards the mouth.

*Formation.*—"Portlandien inférieur (Astartien) du Jura Neuchâtelois.

"*Collections.*—Museum of Neuchâtel. Coll. M. Gressly." *Desor.*

Holectypus giganteus, *Desor*. Syn. *Discoidea speciosa*, Agassiz, Échinoderm. Foss. de Suisse, tabl. 6, fig. 16.
— — Desor, Monogr. des Galérites, tabl. 10, fig. 13.

"A very large, depressed species. The base is furnished with numerous close-set tubercles, but without a regular arrangement; mouth opening proportionally very small; anal opening pyriform, hardly occupying half the space between the peristome and the border."

*Formation.*—"Corallien de la Vallée de la Birse.

"*Collection.*—M. Gressly; very rare." M. Desor adds, in a note to the above description, in his 'Synopsis des Échinides Foss.,' that it is by mistake this species has been confounded by M. Agassiz and himself with *H. speciosus*, Münst. The arrangement of the tubercles is very different in *H. giganteus*; the regular concentric disposition observed in *H. speciosus* is absent in *H. giganteus*; their regular distribution in the one, and irregular distribution in the other, form a diagnostic character between these two gigantic *Holectypi*.

## *Genus*—PYGASTER, *Agassiz.* 1834.

Galerites? (pars), Lamarck. 1816. (?)
Clypeus (pars), Phillips. 1829.
Echinoclypeus (pars), De Blainville. 1830.
Nucleolites (pars), Desmoulins. 1837.

It is by no means certain that Lamarck was acquainted with the urchins now included in the genus *Pygaster*, although he is invariably cited as the author of one of the most typical species of the group, for reasons which will be given in the article on *Pygaster umbrella*; it appears that Lamarck's reference to Klein's tab. 12 was an error. In his genus *Echinoclypeus*, De Blainville associated three distinct types of Echinides,—*Clypeus*, *Pygaster*, and *Conoclypeus*; whilst Desmoulins placed the *Pygasters* with his *Nucleolites*, urchins which have limited petaloidal ambulacra, wide poriferous zones, small and irregular-disposed tubercles, with a five-lobed edentulous mouth; characters which are quite opposite to those possessed by the *Pygasters*. The only explanation that can be given for these errors of arrangement by authors of such eminence, is the fact that neither De Blainville nor Desmoulins had seen a *Pygaster*, as appears from a note by the latter author, appended to his description of the species in his 'Synonymie générale.'*

M. Agassiz has the merit of having first detected and pointed out the leading characters of the genus *Pygaster*, which he established from a figure of the only species then known, and which has subsequently been proved to be one of the most natural and best-defined of all the genera of the Echinoidea exocyclica.

The test is sub-pentagonal, more or less elevated and convex on the upper surface, and concave at the base; the ambulacral areas are narrow, with four or six rows of small tubercles, the marginal rows only extending from the base to the apex of the areas.

The poriferous zones are narrow, simple, and complete; and the pores are strictly unigeminal throughout.

The inter-ambulacral areas are in general four times the width of the ambulacral; each of the large pentagonal plates supports numerous tubercles, and those at the border have from six to eight. The tubercles are more or less regularly arranged in vertical and horizontal rows; it is only the representatives of the two primary rows of each area which extend from the mouth to the disc, all the others disappear in succession on the sides, and the length of each is in proportion to its proximity to the two primary rows. The tubercles are small, and nearly equal-sized; they are perforated, and raised on bosses with smooth, uncrenulated summits; depressed, ring-like areolas surround their base; and the inter-

* 'Études sur les Échinides,' p. 354, No. 2.

tubercular surface of the plates is covered with numerous small miliary granules, which form circles around the areolas. The basal tubercles are larger than those on the upper surface, their areolas are more excavated, and they have a quadrate or hexagonal figure, which makes a striking contrast to their circular form on the upper surface.

The apical disc is large, composed of five ovarial and five ocular plates; the right antero-lateral ovarial is the largest, it extends into the centre of the disc, and supports a large madreporiform body on its surface. The five ocular plates are small, and wedged between the angles left by the ovarials.

The anal opening is situated on the upper surface of the single inter-ambulacrum; it is a very large, oblong, or pyriform aperture in the test, and in the living urchin appears to have been closed by a tegumentary membrane; in all the species at present known, *P. pileus* excepted, the discal and anal openings are continuous; but in that species a portion of the test separates the apical disc from the vent.

The mouth opening is circular, and situated in a depression in the centre of the base; the peristome is divided by deep notches into ten equal-sized lobes. Remains of jaws have been found in some species; and imprints of ten carinæ, radiating from the centre to the periphery, are seen in the moulds of others. The *Pygasters*, therefore, possessed masticating organs probably allied in structure to those I have already described in *Holectypus depressus*, Leske.

The spines are small, short appendages, which resemble the same parts in *Echinus*, and, like them, their surface is covered with well-marked longitudinal lines.

The *Pygasters* form a type of structure which nearly approaches the *Hemipedinas*, of the family Diademadæ; like them, the tubercles are perforated, their bosses have smooth, uncrenulated summits, and they are arranged in regular vertical and horizontal rows. The poriferous zones are narrow and unigeminal; the mouth opening is circular and decagonal; and they possess organs of mastication.

Unlike the Diademadæ, however, the *Pygasters* are true *exocyclous urchins*, and have a large vent, placed without the circle of the apical disc. They differ from *Holectypus* in having the tubercles larger, and the vent at the upper surface; and from *Hyboclypus* in the absence of the dorsal sulcus in which the vent is situated in that genus. They are distinguished from *Clypeus*, *Echinobrissus*, *Catopygus*, *Pygaulus*, and other Echinobrissidæ, in having perforated tubercles arranged in rows; narrow, complete poriferous zones; and the mouth armed with jaws. They form, in fact, a well-defined group of urchins, separated by prominent organic characters from all the others.

The *Pygasters* first appeared in the lowest beds of the Inferior Oolite; and their different species are discovered in the Cornbrash, Calcareous Grit, Coral Rag, and Kimmeridge Clay. They have been found likewise in the Gault.

A. *Species from the Inferior Oolite* = 10^e *Étage Bajocien*, d'Orbigny.

PYGASTER SEMISULCATUS, *Phillips*. Pl. XIX, fig. 1 *a, b, c, d, e, f, g*.

| | |
|---|---|
| CLYPEUS SEMISULCATUS. | Phillips, Geology of Yorkshire, vol. i, p. 104, pl. 3, fig. 17 (two thirds nat. size), 1829. |
| — ORNATUS. | Buckman, in Murchison's Geology of Cheltenham, 2d ed., p. 95, 1845. |
| NUCLEOLITES SEMISULCATA. | Desmoulins, Études sur les Échinides, Tabl. Synoptique, p. 362, 1837. |
| PYGASTER SEMISULCATUS. | Agassiz, Prodrome d'une Monogr. des Échinodermes, p. 185, 1837. |
| — — | Dujardin, in Lamarck's Hist. Naturelle des Animaux, 2^me édit., tome iii, p. 353, 1840. |
| — BREVIFRONS. | M'Coy, Annals and Magazine of Natural History, 2d series, vol. ii, p. 414. |
| — SEMISULCATUS. | Wright, Annals and Magazine of Natural History, 2d series, vol. ix, p. 89, 1852. |
| — — | Forbes, in Morris's Catalogue of British Fossils, 2d ed., p. 88, 1855. |
| — — | Desor, Synopsis des Échinides Fossiles, p. 165. |

Test sub-pentagonal, depressed, sometimes conoidal; ambulacral areas prominent and convex, with four rows of tubercles at the margin, diminishing to two marginal rows above; inter-ambulacra four times the width of the ambulacra, with from eighteen to twenty vertical rows of tubercles at the margin, diminishing to two rows in the upper part; marginal fold acute, base flat, towards the centre very concave; mouth sunk in a depression, peristome nearly equally decagonal; discal opening wide, central; anal opening large, semisulcate, not contracted towards the disc, extending one half the distance between the centre of the apical disc and the posterior border.

*Dimensions.*—Height, one inch and a half; transverse diameter, three inches and one eighth.

*Description.*—I have omitted from the list of synonyms the *Galerites umbrella*, Lamarck, because that species is clearly the *Clypeus sinuatus*, Leske; likewise the *Pygaster umbrella*, Agassiz, of the 'Échinodermes Fossiles de la Suisse,' and of Desor's 'Monographie des Galérites,' inasmuch as the figures given in these works represent, probably, another British species. It is extremely doubtful whether *Pygaster semisulcatus* has been yet found out of the English Inferior Oolite; it was said to have been discovered in the Bajocien stage of the department of the Sarthe, but M. Cotteau informs me that the specimen supposed to have been collected therefrom, turns out to be a Gloucestershire fossil, which had got by mistake into a collection of Chauffour urchins.

When Professor Phillips figured *Pygaster semisulcatus* in his 'Geology of Yorkshire,' he was not aware that two distinct species of the genus *Pygaster* existed in the Oolites of that county, one collected from the Inferior Oolite of Whitwell, and the other from the Coralline Oolite of Malton; as the type specimen is now lost, it is uncertain whether the Whitwell or Malton urchin was the one sketched in tab. 3, fig. 17 of that work. When Professor Forbes was studying this species, he applied to Professor Phillips for the type of *P. semisulcatus*, and the one sent was a Whitwell specimen, which I compared with my Inferior Oolite urchins, and ascertained the identity of the species.

It was assumed, therefore, by Professor Forbes, that the Whitwell urchin was *P. semisulcatus*, and his beautiful plate of this species, in the fifth Decade of the 'Memoirs of the Geological Survey,' was lettered accordingly.

The general form is sub-hemispherical, more or less depressed on the upper surface; the base is flat or slightly concave, and the mouth is lodged in a considerable central depression; the circumference is sub-pentagonal, and the bilateral symmetry of the test is very evident in specimens which are free from distortion (fig. 1 *a*); the upper surface is in general convex (fig. 1 *c*), but sometimes in large examples the sides are flattened, and the test then assumes a conoidal figure, when it becomes the *P. brevifrons*, M'Coy.

The ambulacral areas are equidistant, and of equal width, and about one fourth the breadth of the inter-ambulacral areas; the anterior single area is straight and lancet-shaped; the anterior pair are gently bent backwards, and the posterior pair in large individuals have a slight *f*-shaped flexure, occasioned by the great width of the vent (fig. 1 *a*). They are composed, according to the size of the test, of from one hundred and twenty to one hundred and sixty pairs of plates, as weathered specimens show that every third plate carries a primary tubercle (fig. 1 *f*). There are two complete rows of tubercles on the margins of the areas, which extend without interruption from the peristome to the disc; in each row there are about fifty-eight tubercles; of these, twenty-two belong to the base and margin, and thirty-six to the sides and upper surface (fig. 1 *a*, *b*); within these, two other rows commence about half an inch from the peristome, and extend from thence three quarters of an inch up the sides, about which point they disappear; at the marginal angle sometimes a fifth, or in some cases a sixth, row is introduced for a very limited extent, and the miliary zone in the upper part of the area is filled with small granulations. The poriferous zones are narrow; the pores are strictly unigeminal throughout, one pair of pores nearly corresponding to each of the ambulacral plates. The pores constituting a pair are placed slightly oblique; in some specimens the inner hole is round and the outer is oval, but this character is individual, and not general. The septa are narrow, and form very inconsiderable elevations on the surface (fig. 1 *f*, *h*).

The inter-ambulacral areas are four times the width of the ambulacral; they are composed of about thirty-five pairs of plates, of which about fifteen occupy the base, and twenty the sides; these plates, according to their breadth, support a variable number of tubercles, those at the margin having from nine to ten tubercles on the same horizontal

line (fig. 1 *d*). Two of these rows, the fifth on each side from the centro-sutural line, represent the primary tubercles, and extend from the peristome to the disc; the other rows, as the plates become narrower, disappear at various points on the sides, so that, whilst at the margin of the specimen (fig. 1 *d*) there are twenty rows of tubercles, in the vicinity of the apical disc there are only two rows (fig. 1 *a*). The tubercles are nearly of the same size, and form very regular horizontal and vertical rows on both areas; those of the primary rows are larger in the upper surface, and all the basal tubercles are so likewise. The tubercles, which are perforated, are raised on small bosses, with smooth summits (fig. 1 *e*, *f*); their base is encircled by narrow, sunken, ring-like areolas, which are much more developed around the ventral than on the dorsal tubercles; the circumference of the areolas is surrounded by a circle of small granules, and the intervening portion of the plates is covered with a like-sized miliary granulation (fig. 1 *d*, *e*, *f*).

The opening for the apical disc is very large, half an inch in diameter, but in only one of the hundreds of specimens of this species which I have examined has a vestige of the plates remained. These consist of four ovarial, and three ocular; the ovarial plates are small, and dove-tail with the angular incisions in the discal opening; the spongy madreporiform body is large, extending inwards and backwards, and the ovarial holes are perforated near the apex; the ocular plates are very small, situated at the summit of the ambulacral areas, and the eye-holes are perforated near their margin; as the centre of the disc is absent; the form of its posterior boundary is therefore unknown.

The anal aperture is a very large, oblong-oval opening, which occupies nearly the upper half of the single inter-ambulacrum (fig. 1 *a*). Its shape forms an important diagnostic specific character, and ought to be carefully noted in making determinations of the species. The borders of the opening are incurved, and the vent appears to have lain in a depression; at the point where the plates incline towards the lateral parts of the vent, two tumid ridges extend downwards to the posterior border, having a slight concave depression between them (fig. 1 *a*, *c*). In young specimens, the anal aperture is proportionately smaller.

The base is concave, and the mouth central, and placed in a considerable depression. It is of moderate size, about one fifth the diameter of the test; the peristome is nearly equally decagonal, the ambulacral being larger than the inter-ambulacral lobes; the notches are wide, and the margin is everted (fig. 1 *b*). Although I have searched diligently for the teeth, I have never yet seen a vestige of one, although there cannot be a doubt that the *Pygasters* possessed jaws like those of *Holectypus depressus*, Leske.

The spines adhering to the fine specimen I have figured are short and needle-shaped, and delicately striated longitudinally.

*Affinities and differences.—Pygaster semisulcatus* resembles in many points *Pygaster umbrella*, Agassiz, but is distinguished from that urchin by the following characters: The tubercles, especially those on the upper surface, are disposed in much more regular

horizontal and vertical rows, the ambulacral areas are not so lanceolate, the anal opening is wider in the upper part, and does not descend so far down the inter-ambulacrum as in *P. umbrella*, in which it has a well-marked pyriform shape, and is much contracted in the upper part like a key-hole. (Compare Pl. XIX, fig. 1, with Pl. XX, fig. 2.)

*Locality and Stratigraphical position.*—This species has been collected from the Pea-grit, Inferior Oolite of Crickley, Birdlip, Shurdington, Leckhampton, Cleeve, and Sudeley Hills, Gloucestershire, where it is abundant, although good specimens are rare. I possess a series of all sizes, from half an inch to three inches and a half in diameter. It is found likewise in the shelly freestone at Leckhampton, and I have extracted small specimens from the planking beds of the Great Oolite at Minchinhampton Common. In Yorkshire it is collected only from the Inferior (Great?) Oolite at Whitwell. In the Pea-grit at Crickley Hill it is associated with *Ammonites Murchisonæ*, Sow., *Nautilus truncatus*, Sow., *Terebratula simplex*, Buck, *Terebratula plicata*, Buck; and *Thecidium triangulare*, d'Orbig., is often adherent to its test. *Pseudodiadema depressum*, Agas., *Hyboclypus agariciformis*, Forb., *Cidaris Fowleri*, Wright, *Cidaris Bouchardii*, Wright, and *Acrosalenia Lycetti*, Wright, are its usual associates.

PYGASTER CONOIDEUS, *Wright*. Pl. XIX, fig. 2 *a*, *b*, *c*, *d*, *e*, *f*.

| | | |
|---|---|---|
| PYGASTER CONOIDEUS. | | Wright, Annals and Magazine of Natural History, 2d series, vol. ix, p. 91, pl. 3, fig. 1. |
| — | — | Forbes, in Morris's Catalogue of British Fossils, 2d ed., p. 88. |
| — | — | Salter, Memoirs of the Geological Survey, Decade V, pl. 8. |
| — | — | Desor, Synopsis des Échinides Fossiles, p. 166. |

Test pyramidal, pentahedral; posterior border sub-acute; ambulacral areas narrow and prominent, with two rows of small marginal tubercles, and two imperfect, incomplete rows within; inter-ambulacral areas upwards of four times the width of the ambulacral; tubercles of both areas very small, and scattered without much order on the surface of the plates, which are covered with minute spaced-out granules; vent small, occupying rather more than the upper third of the single inter-ambulacrum; marginal fold acute, sides of the pentahedron rising abruptly therefrom; base flat, mostly concealed by the matrix.

*Dimensions.*—Height, one inch and three tenths; antero-posterior diameter, two inches and nine twentieths; transverse diameter, two inches and four tenths.

*Description.*—This very rare *Pygaster* is remarkable for its pyramidal form; the

sides, which are pentahedral, rise abruptly from the marginal fold; the anterior and lateral pairs of inter-ambulacra form angles of from 50° to 55° with the base, and the single inter-ambulacrum makes an angle of about 42° (fig. 2 *a*). The ambulacral areas are narrow and prominent, and placed nearly equidistant from each other; the single anterior area is straight; the anterior pair curve forwards, upwards, and backwards; the posterior pair rise forwards and upwards for three parts of their course, then curve inwards towards the anal opening, and terminate near the posterior part of the disc (fig. 2 *a*). There are two complete rows of tubercles extending from the peristome to the disc, arranged on the margins of the areas, a primary tubercle being developed on every third plate (fig. 2 *d*); two inner rows commence near the mouth, pass round the angle, and rise half way up the sides, but the tubercles thereof are smaller, less regular in their arrangement, and more incomplete than the marginal rows; like them, however, one tubercle rises from every third plate; at the widest part of the areas, near the border, a few tubercles form a fifth row of very limited length (fig. 2 *b*).

The poriferous zones are narrow, and sunk in slight depressions (fig. 2 *c*); the pores are strictly unigeminal throughout; the pores are nearly equal, and the septa develop a small ridge between them (fig. 2 *d*); one pair of pores corresponds to a pair of ambulacral plates; as there are thirty marginal tubercles on the upper surface of one area, and every third plate supports one tubercle, it follows that there are ninety pairs of pores in the poriferous zones on the upper surface alone; as the areas are only partially exposed at the base, the pores cannot be counted in that region.

The inter-ambulacral areas are more than four times as wide as the ambulacral; there are eighteen pairs of plates in each area, between the margin and the disc; each plate is bent in the middle (fig. 2 *d*), and supports numerous small tubercles, their number on the plates varying according to their length; they are disposed in single transverse rows on the centro-sutural half, and in double rows on the zonal half of the plates; near the margin, there are four tubercles in the single row, and three pairs of tubercles in the double rows, but on the shorter plates they are much fewer and less regular (fig. 2 *d*). On the under surface the tubercles are larger, and arranged in concentric rows; there are from six to eight tubercles on each plate, the smooth areolas of which nearly touch (fig. 2 *b*).

The tubercles on the upper surface of this species are extremely small, and form a remarkable contrast to those in the same region of the test in *Pygaster semisulcatus;* their areolas are scarcely sunk, and the granulations on the surface of the plates are very small, and placed rather widely apart (figs. 2 *a, c, e*).

The single inter-ambulacrum is concave between the disc and the border, and the anal opening occupies its upper third (fig. 2 *e*); this aperture is of the same shape, but smaller than in *P. semisulcatus* (fig. 2 *a*); the portion of the area below the vent is flattened, and the tumid ridges are absent.

The base is partly concealed by firmly adhering matrix, which cannot be removed without the risk of splintering the test; enough, however, is exposed, to show that

the base is slightly concave, and that the tubercles in that region are larger than those on the upper surface (figs. 2 *b* and *f*).

*Affinities and differences.*—This species resembles *P. semisulcatus* in its pentagonal form, but it is pyramidal and pentahedral, and is neither hemispherical nor depressed; it is distinguished from that species by a greater prominence of the ambulacra, the smallness of the tubercles, the superficiality of the areolas, the microscopic character of the granules, and the smallness of the vent. It is a very rare species, as I have only seen a specimen in Mr. Lycett's cabinet, besides the one now figured in detail.

*Locality and Stratigraphical position.*—I collected this urchin from the Pea-grit at Crickley Hill. Mr. Lycett's specimen was found in the lower beds of the Inferior Oolite, near Stroud.

## B. *Species from the Cornbrash* = 11$^{e}$ *Étage Bathonien*, d'Orbigny.

PYGASTER MORRISII, *Wright.* Pl. XX, fig. 1 *a, b, c, d, e, f.*

| | | |
|---|---|---|
| PYGASTER MORRISII. | | Wright, Annals and Magazine of Natural History, 2d ser., vol. ix, p. 92, pl. 4, fig. 1. |
| — | — | Forbes, in Morris's Catalogue of British Fossils, 2d edit., p. 88. |
| — | — | Wright, Memoirs of the Geological Survey, Decade V. Notes on British species of Pygasters. |
| — | — | Desor, Synopsis des Échinides Fossiles, p. 166. |

Test pentagonal, depressed; marginal fold very tumid; single inter-ambulacrum much truncated; ambulacral areas wide, convex, and prominent, with six rows of tubercles; inter-ambulacral areas wide, with rather large tubercles, in very regular vertical and horizontal rows, from twenty to twenty-two in each space on the same horizontal line at the equator; base flat, concave towards the mouth opening, which is small; anal opening long, pyramidal, occupying two thirds of the upper surface of the inter-ambulacrum.

*Dimensions.*—Height, eight tenths of an inch; antero-posterior diameter, two inches and three twentieths of an inch; transverse diameter, two inches and a quarter of an inch.

*Description.*—This is one of our rarest *Pygasters*, and the specimen figured is the only one I know. It has a thick test, with a very pentagonal outline, is much depressed on the dorsal surface, has a flat base, tumid sides, is remarkable for the size of its tubercles, and for the regularity of their arrangement in vertical and horizontal rows.

The ambulacral areas are wide, convex, and prominent, and form an exception to the generalisation of M. Agassiz, that in the genus *Pygaster* the ambulacra are furnished with only four rows of tubercles, for in this species at the widest part of the area there are six rows of well-developed tubercles (fig. 1 *a*, *b*); the two marginal rows, with about forty-five tubercles in each row, extend from the peristome to the disc; the second rows commence at a short distance from the mouth, and extend two thirds of the length of the upper surface; the third rows commence at the base, about half an inch from the border, and extend to about the same distance up the sides of the area (fig. 1 *b*).

The poriferous zones are straight, the pores have moderately thin septa, with only slight elevations on the surface, and there are four pairs of pores opposite each inter-ambulacral plate (fig. 1 *d*).

The inter-ambulacral areas are three times the width of the ambulacral; at the circumference they are furnished with twenty-two rows of tubercles, which attain a greater size and are arranged with more regularity than in any other English species; each plate above the circumference has from eight to nine tubercles developed on its surface (fig. 1 *d*); those on the half of the plate nearest the centro-suture are arranged horizontally on the same line, whilst the tubercles nearest the zones form double rows in oblique pairs. The tubercles are raised on prominent bosses, and surrounded by wide, sharply defined, sunken areolas (fig. 1 *d*); each areola is surrounded by a circle of granules (fig. 1 *e*); there are thirty-six pairs of plates in each area, twenty-one of which are dorsal and fifteen are basal. The tubercles attain their greatest development at the base, where they are so uniformly arranged, and so closely set together, that they appear to arise from hexagonal spaces (fig. 1 *b*); the areolas are deeply excavated (fig. 1 *f*), and have a square or hexagonal figure, two sides being bounded by granules, the other two by sharp elevations of the areolar border (fig. 1 *f*); of the twenty-two rows of tubercles which occupy the area at the circumference, only six, and these the three central rows of each column, extend from the peristome to the disc, the others disappear at shorter distances, the length of the rows being in proportion to their distance from the margin of the columns.

Although the upper surface of this urchin is much depressed, its sides are tumid, as is well seen in the profile (fig. 1 *c*). The single inter-ambulacrum is much truncated (fig. 1 *a*), and the large anal opening, which has an oblong shape, occupies the upper three fourths of this area; the discal opening is small, and the plates are all absent.

The marginal angle is obtuse, the outer half of the base is convex, and the inner half concave; the small mouth opening, which is about one sixth the diameter of the test, lies in a deep depression.

The spines are short, stout, needle-shaped bodies, marked with fine longitudinal lines.

*Affinities and differences.*—This species resembles *P. laganoides*, Agassiz, in its depressed form, obtuse basal angle, and truncated single inter-ambulacrum; but

*P. Morrisii* has a greater number of tubercles in the ambulacral and inter-ambulacral areas, *P. laganoides* having four rows in the ambulacral and fourteen in the inter-ambulacral areas, whilst *P. Morrisii* in the same region of the corresponding area possesses six rows and twenty-two rows.

*P. Morrisii* resembles *P. Gresslyi*, Desor, in its general form, in the size and disposition of its tubercles, and in their surrounding granulation, but *P. Morrisii* is more depressed, has a larger anal opening, and more rows of tubercles in both areas.

*Locality and Stratigraphical position.*—This rare species was collected by Mr. W. Buy from the Forest Marble or Cornbrash near Stanton, Wilts. The specimen figured (Pl. XX, fig. 1) is the only one I know. I have seen a *Pygaster* from the Great Oolite near Cirencester, which resembles my urchin; but the specimen was crushed, and not otherwise determinable; it had the same number of tubercles in the areas as *P. Morrisii*. I dedicate this species to my friend Professor John Morris, to whose valuable labours British palæontologists are under so many lasting obligations.

### C. *Species from the Coral Rag* = 14$^{e}$ *Étage Corallien*, d'Orbigny.

PYGASTER UMBRELLA, *Agassiz*. Pl. XX, fig. 2 *a, b, c, d, e, f.*

| | | |
|---|---|---|
| PYGASTER UMBRELLA. | | Agassiz and Desor, Catalogue raisonné, Ann. des. Scienc. Nat., 3$^{e}$ série, tom. vii, p. 144, 1847. |
| — | — | Bronn, Index palæontologicus, Band i, p. 1066, 1848. |
| — | — | D'Orbigny, Prodrome de Paléontologie, tom. i, 13$^{e}$ étage, No. 510. |
| — | EDWARDSEUS. | Buvignier, Statistique géologique, paléontologique depart. de la Meuse Atlas, p. 46, pl. 32, figs. 31—33, 1852. |
| — | UMBRELLA. | Wright, Memoirs of the Geological Survey, Decade V, pl. 8. Note on British Pygasters, 1856. |
| — | — | Cotteau, Études sur les Échinides Foss., p. 194, pls. 27, 28, fig. 1, 1856. |
| — | — | Desor, Synopsis des Échinides Fossiles, p. 165, 1857. |

Test large, more or less elevated, sometimes circular, oftener sub-pentagonal; ambulacral areas narrow, with two complete marginal rows of tubercles, and two incomplete rows, which commence near the peristome, and extend only half way up the sides; inter-ambulacral areas wide, with from sixteen to eighteen rows of tubercles at the equator, which are small and rather irregularly disposed on the upper surface, but large and arranged in regular horizontal and vertical series at the circumference and base; anal opening distinctly pyriform, occupying rather more than one half the length

of the upper surface of the single inter-ambulacrum; base concave; mouth opening small, peristome equally decagonal, apical disc large, composed of unequal-sized genital plates; the right antero-lateral very large, and extending backwards beyond the centre; ocular plates small, eye-holes marginal.

*Dimensions.*—In the following table I have given the dimensions of four English specimens from different localities enumerated in this article, and have added the measurements of M. Cotteau's urchin from Châtel-Censoir.

| *Pygaster umbrella*, Agass. | Height. | Transverse diameter. | Antero-posterior diameter. | Length of discal and anal opening. |
|---|---|---|---|---|
| | Inches. | Inches. | Inches. | Inches. |
| Specimen from Malton . . | 2 | $4\frac{1}{4}$ | $4\frac{1}{10}$ | $1\frac{3}{4}$ |
| ,, ,, Headington . | $1\frac{1}{2}$ | $4\frac{1}{4}$ | $4\frac{1}{10}$ | indeterminable |
| ,, ,, Lyneham . | $1\frac{1}{10}$ | 3 | $2\frac{19}{20}$ | $1\frac{3}{20}$ |
| ,, ,, Farringdon . | $1\frac{7}{10}$ | $2\frac{8}{10}$ | $2\frac{7}{10}$ | $1\frac{1}{10}$ |
| ,, ,, Malton . . | $1\frac{1}{20}$ | $2\frac{7}{10}$ | $2\frac{6}{10}$ | $1\frac{1}{4}$ |
| ,, ,, Châtel-Censoir . | $1\frac{6}{10}$ | $3\frac{6}{10}$ | $3\frac{7}{10}$ | $1\frac{3}{4}$ |

*Description.*—The greatest confusion exists regarding the synonyms of this species. MM. Agassiz, Desor, and Cotteau, who have each figured and described this urchin, cite *Galerites umbrella*, Lam., as its type; now, Lamarck* does not say that he had seen the fossil, but refers to "Leske apud Klein, p. 157, t. 12, and 'Encycl. Méthod.,' pl. 142, figs. 7, 8," as the species intended. After consulting the original figure in Klein, which represents *Clypeus sinuatus*, Leske, in the Dresden Museum, I do not see how such a reference can be sustained, as the *Clypeus* in question belongs not only to a different genus, but even to a distinct family of the Echinoidea. As Deslongchamps,† Defrance,‡ De Blainville,§ and Desmoulins‖ all founded their synonyms on this mistake, I have not cited these authors in my list, for the obvious reason, that their references were made under an erroneous impression. It is strange that MM. Agassiz and Desor, when correcting the synonyms of the *Pygasters*, in their 'Catalogue raisonné,' should not have de-

* *Galerites umbrella.* Lamarck, 'Animaux sans Vertèbres,' tom. iii, p. 23, 1816.

† *Galerites umbrella.* Deslongchamps, 'Encyclopédie méthodique Hist. Nat. des Zoophytes,' tom. ii, p. 434.

‡ *Nucleolites umbrella.* Defrance, 'Dict. des Sciences Naturelles,' art. Galérites, tom. xviii, p. 87, 1825.

§ *Echinoclypeus umbrella.* Blainville, 'Dict. des Sciences Naturelles,' art. Zoophytes, tom. ix, p. 189, 1830.

‖ *Nucleolites umbrella.* Desmoulins, 'Études sur les Échinides,' p. 354, No. 2, 1837.

tected this primary error; so true is it, that unless we compare typical specimens with each other, the highest authorities may be misled by imperfect figures.

In the 'Échinodermes Foss. de la Suisse,' M. Agassiz* figured as *Pygaster umbrella*, an urchin found by M. Gressly in "le Portlandien du Jura Soleurois." This figure was reproduced by M. Desor,† in his 'Monographie des Galérites.' In the 'Catalogue raisonné,' however, these authors have changed the name of the Swiss urchin to *P. dilatatus*, and have given that of *P. umbrella* to a species from the Coral Rag of Châtel-Censoir (Yonne).

In the "Études sur les Échinides Foss. du département de l'Yonne," M. Cotteau has given for the first time good figures with details, and a description of this species; and he has likewise kindly sent me type specimens thereof, so that I have ample materials for comparing our specimens with *P. umbrella*, Agassiz (1847). Unfortunately M. Cotteau's figured specimen is partly denuded of its shell, and my specimen is only an interior mould, but the general form of the test, and the figure of the vent opening, are well preserved.

The test of *Pygaster umbrella* is thick; in some specimens it has nearly a circular, in others a sub-pentagonal, form; in some the upper surface is moderately convex (fig. 2 *c*), in others it is more or less depressed; in fact, its general outline varies much with age, sex, and external conditions, so that it is difficult to give a general description of its form that will be true for three or four specimens from different localities.

The test (fig. 2 *a*, *c*) was kindly given me by my friend Mr. J. G. Lowe; it exhibits the var. *a*, with a circular outline, and is selected in consequence of the fine preservation of the shell on its upper surface. The ambulacral areas are narrow and lanceolate (fig. 2 *a*), the single area and the anterior pair are straight, and the posterior pair are only slightly curved inwards at their upper part. They have two marginal rows of tubercles, which extend uninterruptedly from the peristome to the disc, there are thirty tubercles on each row between the margin and the apex, and from eighteen to twenty at the base; midway between the peristome and the margin two inner rows of tubercles commence, which extend only one third the distance up the sides, and at the widest part of the areas a few additional tubercles forming a fifth row exist (fig. 2 *d*). As the marginal tubercles are developed on every third plate, it follows that there are $48 \times 3 = 144$ plates in each area. The poriferous zones are narrow (fig. 2 *d*), one pair of pores corresponding to one ambulacral plate; the septa are narrow, and slightly elevated on the surface; and there are from six to seven pairs of pores opposite each inter-ambulacral plate (fig. 2 *d*).

* *Pygaster umbrella.* Agassiz, 'Description des Echinodermes Fossiles de la Suisse,' 1re partie, p. 8, tab. 12, figs. 4—6, 1839.

*Pygaster umbrella.* Agassiz, 'Catalogus Systematicus Ectyporum Echinodermatum Fossilium,' p. 7, 1840.

† *Pygaster umbrella.* Desor, 'Monographie des Galérites,' p. 77, tab. 12, figs. 4—6, 1842.

The inter-ambulacral areas are four times as wide as the ambulacral; there are about thirty-two pairs of plates in each column, of which eighteen belong to the upper surface, and fourteen to the base; the plates are bent in the middle, and at the widest part of the area, each plate supports seven tubercles; the four nearest the zones are arranged in oblique pairs, and the three nearest the centro-suture in horizontal lines (fig. 2 *d*); at the margin there are from eighteen to twenty tubercles in one horizontal series.

The tubercles on the upper surface are small (fig. 2 *a*); they have slightly sunken areolas, and are raised upon small bosses with smooth summits (fig. 2 *f*); the areolas are surrounded by six small granules (fig. 2 *f*), and others are scattered sparingly on the surface of the plates; these granules, like the tubercles, are all perforated (fig. 2 *d*).

The tubercles at the base are much larger (fig. 2 *b*), and they are arranged in close-set, horizontal lines; the areolas are more excavated, and rather square-shaped; they are bounded by a single row of granules (fig. 2 *g*); and the tubercles of both areas are about the same size.

The base is concave, slightly so at the sides, but much depressed at the centre; the mouth opening is small, and the peristome is equally decagonal. "Its circumference is armed with ten prominent carinæ, which, in the interior moulds, have left on the borders of the inter-ambulacral areas very apparent imprints." * These carinæ, which M. Desor† had already observed in a specimen of *Pygaster costellatus*, are doubtless destined in the *Pygasters* to replace the auricles of the Cidaridæ and Clypeasteridæ. M. Michelin‡ has recently discovered in a *Pygaster umbrella* a masticating apparatus, which resembles that of a *Clypeaster*, the united pieces of which form a very acute pyramid.

The anal opening is very large, and occupies more than the upper half of the single inter-ambulacrum (fig. 2 *a*); it has a pyriform figure, contracted above and swelling out below, which, with the discal space, produces a keyhole-like opening in the test. In most of the specimens this aperture is not symmetrical, and bulges more to the left than to the right side; in fig. 2 *a* a portion of the test is broken, which gives the vent in this specimen a more symmetrical form than in all the others I have examined (fig. 2 *c*).

The greater portion of the apical disc is preserved in one of the specimens from Malton, kindly given me by Dr. Murray (fig. 2 *b*, *e*); the genital plates have an irregular rhomboidal form, with pointed apices, and perforations for the canals near the apex; the right antero-lateral plate is disproportionately large, and the shield-like madreporiform body extends backwards into the centre of the disc (fig. 2 *e*); the ocular plates are small triangular bodies wedged into the angles formed by the genitals; the eye-holes are marginal and lodged in a depression between the plate and the apex of the ambulacral area (fig. 2 *e*); the surface of

* Cotteau, 'Études sur les Échinides Foss.,' p. 197.

† 'Monogr. des Galérites,' p. 76.

‡ Hardouin Michelin, Déscription de quelques nouvelles espèces d'Échinodermes fossiles, 'Revue et Magasin de Zoologie,' 2e série, tom. v, p. 36, 1853.

all the disc plates is covered with numerous small granules; and still smaller granules are scattered over the surface of the madreporiform body (fig. 2 *e*).

*Affinities and differences.*—This species very much resembles *Pygaster semisulcatus*, Phil., and was for a long time mistaken for that species; Professor Phillips having stated that *P. semisulcatus* was common to the Great (?) Oolite of Whitwell and the Coralline Oolite of Malton; this, however, I have proved, by an examination of the specimens, to be an error, the Malton *Pygasters* being quite distinct from the Whitwell species.

In *P. umbrella* the tubercles on the upper surface are always smaller, and not very regularly arranged in vertical and horizontal rows; the bosses are less elevated, the areolas less defined, and the intervening granules smaller and fewer in number than in *P. semisulcatus*. The discal opening is smaller; the anal opening is longer, more pyramidal, and seldom symmetrical, occupying sometimes two thirds of the area; the basal tubercles of both species are nearly alike in size; in *P. umbrella*, however, there is a much greater disproportion between the size of the tubercles on the upper and under surfaces of the test than exists in *P. semisulcatus*.

*P. umbrella* is easily distinguished from *P. Morrisii* by the size of the tubercles in the latter, its more decided pentagonal form, larger ambulacra, and tumid sides.

*P. dilatatus*, as stated by MM. Agassiz and Desor, "Se distingue du *P. umbrella* par son bord plus tranchant et sa forme plus dilatée." The shape of the anal opening is different, and it wants the pyramidal figure so characteristic of *P. umbrella*; it belongs likewise to a different stratigraphical horizon, having been collected from the "Portlandien du Jura Soleurois, carrière de Greifel (vallée de la Birse);" whilst *P. umbrella* is found only in the Coral Rag.

*Locality and Stratigraphical position.*—I have collected this urchin from the lower calcareous grit at Headington, near Oxford; from the Coralline Oolite of Malton, Yorkshire; from the Coral Rag near Farringdon, Berks; and from the Coral Rag of Lyneham and Calne, Wilts; in the two latter localities it was associated with *Cidaris florigemma*, *Pseudodiadema versipora*, *P. mamillanum*, and *Echinobrissus scutatus*—all true Corallian forms.

On the Continent it has been collected by M. Cotteau from the "Calcareo-siliceuses des environs de Druyes, à Châtel-Censoir, et à Montillot (Yonne);" by M. Buvignier from the Coral Rag environs of Saint Mihiel (Meuse); and M. Sæmann, of Paris, kindly sent me a specimen which was obtained from the Coral Rag of Commercey (Meuse).

# NOTES

## On Foreign Jurassic species of the genus PYGASTER nearly allied to British forms, but which have not yet been found in the English Oolites.

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Pygaster laganoides, *Agassiz.* Échinoderm. Foss. Suisse, tabl. 12, figs. 13—16.
*Desor.* Monogr. des Galérites, tabl. 11, figs. 5—7.

Test sub-circular, depressed; four rows of tubercles in the ambulacra, which are one third the width of the inter-ambulacra; twelve rows of tubercles in the inter-ambulacra; the tubercles are large, and nearly all of the same size; base concave, mouth opening large, peristome feebly notched; anal opening large, of an elongated form, and occupying nearly two thirds of the single inter-ambulacrum.

*Dimensions.*—Height, six tenths of an inch; transverse diameter, one inch and six tenths; antero-posterior diameter, one inch and a half.

*Formation.*—Bathonien, "Calcaire à polypiers de Ranville," Normandy.

*Collections.*—Deslongchamps, Michelin, d'Orbigny; my cabinet.

Pygaster Gresslyi, *Desor.* Monogr. des Galérites, p. 80. Synopsis des Échinides Foss., tabl. 22, figs. 1, 2.
*Cotteau.* Études sur les Échinides Foss., pl. 28, figs. 2—6.

Test thin, small, sub-pentagonal, depressed; inflated at the sides, flat at the base, ambulacra with four rows, inter-ambulacra with twelve rows of tubercles at the circumference; the tubercles are large, equal-sized, and surrounded by granules; anal opening pyriform, contracted near the disc; base concave, mouth opening moderate in size, peristome deeply notched; tubercles at the base surrounded by hexagonal areolas.

*Dimensions.*—Height, six tenths of an inch; transverse diameter, one inch and a half; antero-posterior diameter, nearly one inch and a half.

*Formation.*—Corallien, "Couches supérieures de l'étage corallien, et recueillis dans les carrières de Vauligny près Tonnerre (Yonne)." *Cotteau.* "Dans un banc à coraux du Portlandien, à Rædersdorf (Haut-Rhin)." *Agassiz.*

*Collections.*—M. Rathier, M. l'abbé Bellard, M. Gressly, M. Cotteau. Rare.

PYGASTER PATELLIFORMIS, *Agassiz.* Échinoderm. Foss. Suisse, tabl. 13, figs. 1—3.
*Desor.* Monog. des Galérites, tabl. 11, figs. 11—13.

Test thick, hemispherical, more or less depressed; circumference sub-pentagonal; tubercles large, equal-sized, and arranged in regular rows; ambulacra with four rows of tubercles; inter-ambulacra four times the width of the ambulacra, with fourteen rows of tubercles; all the tubercles surrounded by small granules; anal opening large, pyriform, contracted above, wide below, occupying two thirds the length of the area; mouth opening large, peristome deeply notched.

*Dimensions.*—Height, one inch and a quarter; transverse and antero-posterior diameters, three inches.

*Formation.*—"Kimmeridge de Lauffon dans la vallée de la Birse (Berne)." *Agassiz.*

*Collections.*—Museum of Neuchâtel, M. Gressly. Very rare.

PYGASTER DILATATUS, *Agassiz.* Syn. *Pygaster umbrella,* Agassiz. Échinoderm. Foss. Suisse, part. 1e, tabl. 13, figs. 4—6.
*Pygaster umbrella,* Desor. Monogr. des Galérites, tabl. 12, figs. 4—6.

This is the urchin which was described by MM. Agassiz and Desor in their respective works as the type of *Pygaster umbrella.* In their 'Catalogue raisonné,' however, it is separated from *P. umbrella* of the Coral Rag, under the name *P. dilatatus,* with this remark—"Se distingue du *P. umbrella* par son bord plus tranchant et sa forme plus dilatée." The original specimen is an interior mould; M. Gressly has, however, found one with a portion of the test preserved. The fragment of the test is very thick, and has large tubercles, disposed nearly as in *P. patelliformis.* The general form of the mould, and

the shape of the anal opening, which is pyriform, likewise resemble that species. M. Desor, in his 'Synopsis,' remarks—"Grande espèce subpentagonale, étalée, à bord plus aminci que dans aucune autre espèce." It is probable that *P. patelliformis* and *P. dilatatus* may be different conditions of the same species, as they are both Kimmeridge forms.

*Dimensions.*—Height, two inches; transverse diameter, four inches and a half.

*Formation.*—"Kimmeridge du Jura Soleurois, carrière de Greifel, vallée de la Birse Canton de Berne." *Agassiz.* Very rare.

*Collection.*—M. Gressly.

PYGASTER PILEUS, *Agassiz.* Syn. *Pygaster pileus,* Cotteau. Études sur les Échinides Foss., pls. 29 and 30.
*Pileus hemisphæricus,* Desor. Syn. Échinod. Foss., tabl. 22, fig. 6.

Test large, sub-pentagonal; upper surface sub-conical; base flat or sub-concave; ambulacra convex and prominent, with six rows of small, irregularly disposed tubercles; inter-ambulacra wide, with numerous small tubercles disposed partly in single, and partly in double, horizontal rows; middle of the areas depressed, and deprived of tubercles; anal opening pyriform, situated in the lower half of the single inter-ambulacrum; between the apex of the vent and apical disc the test is entire, so that a large triangular space exists in this species, filled with the plates of the test, not found in other *Pygasters,* in all of which, with this exception, the discal opening and vent conjoin; mouth small, situated in a deep depression in the centre of the under surface.

*Dimensions.*—Height, one inch and three quarters; transverse and antero-posterior diameters, four inches.

*Formation.*—"Coral-rag inférieur; dans les couches blanches et pisolithiques de Coulanges-sur-Yonne et de Châtel-Censoir; calcaire à chailles de Druyes." *Cotteau.*

*Collections.*—Muséum d'histoire naturelle de Paris, M. Salomon, M. Cotteau. Very rare. Plaster mould in my cabinet.

In consequence of this *Pygaster* having the anal opening in the lower part of the inter-ambulacrum, and a considerable portion of the test between its apex and the disc, M. Desor has erected it into a new genus, under the name *Pileus hemisphæricus.*

PYGASTER MACROCYPHUS, *Wright*, nov. sp. Davidson's MSS., pl. 2, figs. 1, 2, 3.

Test thick, large, sub-pentagonal; upper surface convex, or more or less depressed; base concave; ambulacra narrow, with two irregular rows of small marginal tubercles, and two short rows, equally irregular, internal to them, which disappear from the upper two thirds of the areas; inter-ambulacra five times the width of the ambulacra; each of the plates near the border supports about seven unequal-sized tubercles; those representing the primary rows are larger than the others; the tubercles, however, are in general large, and very irregularly disposed; the inter-tubercular surface of the plates is covered with an abundance of miliary granules; the bosses of the tubercles are prominent, and surrounded by ring-like areolas, and the granules form circles around each; there is a median depression in the centre of the upper part of the areas; the anal opening is small in proportion to the size of the urchin, and occupies nearly the upper two thirds of the area; it appears to have had a pyriform shape, much of the upper surface of the test is broken in my specimen, so that its precise form is indeterminable; base concave; mouth opening small, one sixth the diameter of the test; peristome deeply notched, lobes equal.

*Dimensions.*—Height, one inch and a half; transverse diameter, four inches and a half.

*Formation.*—Kimmeridge clay, from a cliff between Boulogne-sur-Mer and Portel. Very rare; I only know two specimens.

*Collections.*—Thomas Davidson, Esq., F.R.S. The specimen in my collection was found by M. Bouchard-Chantereaux in the same rock and locality, and was generously given me by that gentleman for this work.

PYGASTER TENUIS, *Agassiz*. Échinoderm. Foss. Suisse, p. 83.
*Desor*. Monogr. des Galérites, tabl. 12, figs. 1—3.

"A very large, sub-pentagonal, depressed species, with small and numerous tubercles, twenty rows in the inter-ambulacral areas, and six in the ambulacral areas, which are not very regular. This species is distinguished by its very thin test.

"*Formation.*—Corallien inférieur (Terrain à chailles) de Fringeli, Canton de Soleure.

"*Collection.*—M. Gressly. Very rare." *Desor.*

## *Genus*—HYBOCLYPUS. 1839.

The urchins grouped in this genus present an assemblage of characters which belong to so many distinct forms of ECHINOIDEA, that they may probably hereafter be found to constitute a separate family, rather than a section of the ECHINOCONIDÆ, with which they are now provisionally placed for want of sufficient materials to justify such a separation.

Their test is thin, and in general as wide as it is long; the anterior half is more elevated than the posterior half, and sometimes rises into a prominent ridge. The surface of the plates is covered with numerous concentric rows of small perforated tubercles, set close together, and raised on low crenulated bosses, which are encircled by sunken areolas, and the intermediate surface is crowded with microscopic miliary granules.

The ambulacral areas are narrow, flexuous, and disjointed at the summit by the length of the apical disc. The three anterior areas terminate at the front of the disc, and the posterior pair at some distance behind them. The single area is lodged in a depression of the anterior border.

The poriferous zones are very contracted; the pores are simple and unigeminal; they are placed close together on the upper surface, and wide apart at the base.

The inter-ambulacral areas are very wide; the single inter-ambulacrum is traversed superiorly by a deep longitudinal valley, which commences behind the apical disc; in the upper part of this channel the wide vent opens on the dorsal region.

The apical disc is central, but not vertical; it is narrow and elongated, in consequence of the length and singular disposition of its component elements; the anterior pair of ovarial plates are shield-shaped; the right plate is the largest, and supports the madre-poriform body; the posterior pair are much larger and longer than the anterior pair, and both pairs are perforated; the single ovarial plate is composed of two or more long, narrow, imperforate pieces, placed end to end in the centre of the disc; the single ocular plate is small; the anterior pair are large, and disposed side by side in a line in the middle of the disc, *between* the anterior and posterior ovarials, instead of being lodged in angles formed *by* them; the posterior pair of oculars are situated at the end of the posterior ovarials (Pl. XXI, fig. 2 *e*), and thereby give lengthened extension to the disc.

I have discovered this singular arrangement of the discal elements in three different species, and now regard it as a valuable generic character (Pl. XX, fig. 2 *e*; Pl. XXII, fig. 1 *e*, and fig. 2 *h*).

The small mouth opening, in general, is situated near the anterior third of the base, which in some species is concave, and much undulated; the peristome is sub-pentagonal or elongated in the antero-posterior diameter.

The *Hyboclypi*, like other ECHINOCONIDÆ, have simple poriferous zones, perforated

and crenulated tubercles, and manifest a disposition to a conical elevation of the upper surface of the test; they are unlike the true type forms of this family, however, in the excentral position of the mouth, the absence of notches from the peristome, in the possession of a longitudinal dorsal valley, and in having the opening of the vent therein; the elongation of the apical disc, the singular disposition of its elements, and the disjunction of the posterior pair from the three anterior ambulacra, which converge around the front of the disc, form a group of negative characters that sufficiently justify our doubts as to the propriety of placing this genus in the family Echinoconidæ.

The *Hyboclypi* resemble in some respects the Collyritidæ, in possessing an elongated apical disc, and having two ambulacral summits, consequent on the disjunction of the anterior from the posterior pair of ambulacra. They have affinities with the Echinobrissidæ in having the test contracted before and expanded behind, the mouth small and excentral, and the vent opening into a longitudinal valley on the dorsal surface; but in the structure of the tubercles, the apical disc, and poriferous zones, they are very different from all the forms of that family.

The *Hyboclypi* form an aberrant type of the Echinoidea, having close affinities with the Echinoconidæ on the one side, and the Collyritidæ on the other; they appear to form a transition link between these two families, and are probably entitled to rank as a separate sub-family.* Our imperfect knowledge of the intimate structure of the mouth, and the presence or absence of jaws in these urchins, make it uncertain how far this separation would be justified by anatomical characters, concealed or unknown.

The different species of this genus have hitherto been only found in the Oolitic rocks; they had their greatest development in the lower division of that series, as all the English species are found chiefly in the Inferior Oolite.

### A. *Species from the Inferior Oolite.*

Hyboclypus agariciformis, *Forbes.* Pl. XXI, fig. 1 *a, b, c, d, e, f, g.*

| | |
|---|---|
| Pygaster sublævis? | M'Coy, Annals and Magazine of Natural History, 2d series, vol. ii, p. 413. |
| Hyboclypus agariciformis. | Wright, Annals and Magazine of Natural History, 2d series, vol. ix, p. 99. |
| — — | Forbes, Memoirs of the Geological Survey, Decade V, pl. 4. |

* The genus *Hyboclypus* is placed by M. Desor, in his 'Synopsis des Échinides Fossiles,' p. 192, in his 2d type of the family Galéridées—"*Genres à appareil apicial alongé, sans plaque génitale impaire.*" I have already shown that the *Hyboclypi* not only possess a single imperforate ovarial plate, but that it is composed of two or more pieces. I must therefore regard M. Desor's definition as a mistake, which has probably arisen from the imperfect condition of the disc in the specimens he examined.

HYBOCLYPUS AGARICIFORMIS. Forbes, in Morris's Catalogue of British Fossils, 2d edition, p. 82.

NUCLEOLITES DECOLLATUS. Quenstedt, Handbuch der Petrefactenkunde, tab. 50, fig. 6, p. 585.

GALEOPYGUS AGARICIFORMIS. Cotteau, Mém. lu à la Soc. Géol. de France, le Juin, 1856.

— — Desor, Synopsis des Échinides Fossiles, p. 167.

Test in general disciform, sometimes convex or conical, with a pentagonal circumference; ambulacral areas narrow, the three anterior straight, the posterior pair sinuous; inter-ambulacral areas wide, unequal, the plates covered with a great number of microscopic tubercles; apical disc small, central, and vertical; anal valley deep, with parallel sides, which gradually expand about the middle of the single inter-ambulacrum; mouth opening small, sub-central, nearer the anterior border; peristome feebly decagonal; poriferous zones narrow, pores unigeminal in the upper surface, at the base wide apart and trigeminal.

*Dimensions.*—The measurements given in the following table are made from four specimens which represent the four varieties this species assumes.

| No. | *Hyboclypus agariciformis*, Forbes. | Height. | Transverse diameter. | Antero-posterior diameter. |
|---|---|---|---|---|
| | | Inches. | Inches. | Inches. |
| 1 | Disciform var. $\alpha$ . . . | $0\frac{7}{10}$ | $3\frac{3}{4}$ | $3\frac{6}{10}$ |
| 2 | Type var. $\beta$ . . . | 1 | $2\frac{8}{10}$ | $2\frac{3}{4}$ |
| 3 | Convex var. $\gamma$ . . . | $1\frac{2}{10}$ | $2\frac{4}{10}$ | $2\frac{4}{10}$ |
| 4 | Conical var. $\delta$ . . . | $1\frac{3}{10}$ | $2\frac{3}{10}$ | $2\frac{3}{10}$ |

*Description.*—In the above table I have given the measurements of four specimens of this urchin, with the view of showing the diversity which exists in the relative proportions of different forms of the same species. Were an observer to find only Nos. 1 and 4, he would be almost justified in considering them distinct species; but when he discovers a number of intermediate forms, by which the depressed, hemispherical, and conical varieties are seen to blend into each other, he is convinced that they all belong to one and the same species, and at the same time is taught the important lesson, that mere difference in form and bulk alone do not constitute a specific character.

This fine urchin, the oldest of the genus, is the largest *Hyboclypus* we are acquainted with; it has a sub-orbicular or sub-pentagonal shape (Pl. XXI, fig. 1), and is the most typical form of the discoidal variety No. *a*. It is expanded and depressed above,

with an acute and sinuous margin arising from the convexity of the inter-ambulacra (fig. 1 *c*); the base is flat, or moderately concave, and is slightly undulated by the depressions formed by the ambulacra, and the convexities by the inter-ambulacra. In general the antero-posterior equals the transverse diameter, but sometimes the transverse exceeds the antero-posterior diameter (fig. 1 *a*, *b*).

The ambulacral areas are very narrow and of unequal width; the anterior single area is the narrowest; the antero-laterals are a little broader than the odd one, and narrower than the postero-laterals (fig. 1 *a*); the three anterior areas converge around the front of the apical disc, whilst the postero-laterals curve sinuously up to its posterior border (fig. 1 *a*); each area has four or six rows of small tubercles, so arranged on the plates that they form oblique rows, which meet in the median line, and branch upwards and outwards, thereby forming V-shaped figures (fig. 1 *d*).

The poriferous zones are narrow; on the dorsal surface the pores are unigeminal, and placed close together (fig. 1 *d*); at the base, in consequence of the plates being broader, they are wider apart, and form slightly oblique ranks of threes; whilst nearer the mouth they lie in very oblique trigeminal ranks (fig. 1 *e*); the oral portions of the ambulacra form a radiate rosette around the mouth.

The inter-ambulacral areas are very wide, but of unequal width; on an average they are eight times as broad as the ambulacrals (fig. 1 *a*, *b*). In one specimen the anterior pair measure at the circumference one inch and three tenths, the posterior pair one inch and eleventh twentieths, and the single area is one tenth of an inch wider than the posterior pair; the margin of all the areas is convex, except the posterior single inter-ambulacrum, which is slightly truncated. The dorsal surfaces of the anterior and posterior inter-ambulacral and of all the ambulacral areas are gently convex; but the single inter-ambulacrum, which is somewhat wider and longer than the others, has a deep valley with parallel vertical sides in its dorsal half; these gradually decline and expand into a concave depression at the lower half (fig. 1 *a*, *c*).

The anal aperture opens into the upper part of this valley immediately below the apical disc; the basal portion of the area is slightly produced and truncated, and forms a lip-shaped process, which imparts a considerable prominence and convexity to it (fig. 1 *c*).

The base is concave and undulated (fig. 1 *b*, *c*), the ambulacra lie in nearly straight, depressed valleys, whilst the inter-ambulacra form gentle convex eminences at the circumference; the mouth opening is small and excentral, being nearer the anterior border; when well exposed, the peristome is seen to be unequally decagonal, the ambulacral being larger than the inter-ambulacral lobes (fig. 1 *b*).

The apical disc is small and central; the margin of the opening is notched with four inter-ambulacral and five ambulacral notches, the former corresponding to the external angle of the ovarial plates, the latter to the margins of the oculars (fig. 1 *a*); the disc appears to have been lodged in a depression; but in none of the hundreds of specimens which I have examined have I detected any of its elements.

The whole of the plates on the dorsal surface are covered with numerous, minute, regular, and nearly equal-sized, perforated tubercles (fig. 1 *f*, *g*), which are raised on bosses with crenulated summits, and surrounded by depressed, ring-like areolas; on one plate near the border I have counted as many as one hundred tubercles; the inter-tubercular surface of the plates is, besides, strewed with microscopic granules, which form circles around the areolas, and fill up the intervening spaces (fig. 1 *f*); the tubercles at the base are much larger and better developed than those on the dorsal surface; at the border and outer third they are very numerous and set close together; the areolas here are diamond-shaped, or hexagonal, and are more excavated, a single row of granules only separates the areolas from each other; towards the mouth they are larger, and not so regularly arranged, having several rows of granules between them (fig. 1 *e*).

*Affinities and differences.*—The adult forms of *H. agariciformis*, Forbes, differ so widely from its other Oolitic congeners, that this urchin cannot be mistaken for either of them; its sub-orbicular shape and depressed dorsal surface distinguish it from *H. gibberulus*, Agassiz, and *H. ovalis*, Wright; the central position of the apical disc, and the absence of any elongation of the single inter-ambulacrum, are diagnostic distinctions between it and *H. caudatus*, Wright. From the *Pygasters*, with which some of the species have been erroneously grouped, it is distinguished by the microscopic character and greater number of its tubercles; the deep anal valley, with vertical walls, in which the vent opens, the small sub-central mouth opening, and narrow apical disc, form a group of generic characters by which the *Hyboclypi* are distinctly separated from the *Pygasters*; whereas the narrow poriferous zones, complete and continuous from the mouth to the apical disc, without any petaloidal expansion on the dorsal surface, distinguish *Hyboclypus* from *Clypeus*, *Echinobrissus*, and *Pygurus*.

*Locality and Stratigraphical position.*—This urchin is very abundant in the lower ferruginous beds of the Inferior Oolite, "the Pea Grit" of Leckhampton, Crickley, Cooper's, Cleeve, and Sudely Hills, and at Camlong Down, near Uley Bury, in Gloucestershire. It was collected from the Inferior Oolite by the Geological Surveyors between Wayford and Seaborough in Dorsetshire, where it was accompanied by *Collyrites ringens*, Agassiz, and *Holectypus hemisphæricus*, Desor. I have found two specimens in the Great Oolite of Minchinhampton, Gloucestershire, along with *Purpurina Morrisii*, *P. nodulata*, Young, and other species of Mollusca characteristic of that formation.

*History.*—This species was first described in my Memoir on the Cassidulidæ of the Oolites, and afterwards figured by Professor Forbes in the IV Decade of the 'Memoirs of the Geological Survey.' In consequence of the opening for the apical disc having a denticulated border, M. Cotteau has proposed for it the new genus *Galeopygus*; but as I

have never seen any of the elements of the disc, I am unable to judge of the value of the character on which the separation of this urchin into a new genus is proposed to be made.

HYBOCLYPUS CAUDATUS, *Wright*. Pl. XXII, fig. 2 *a, b, c, d, e, f, g, h, i, j, k*.

| | | |
|---|---|---|
| HYBOCLYPUS CAUDATUS. | | Wright, Annals and Magazine of Natural History, 2d series, |
| — | — | vol. ix, p. 100, pl. 3, fig. 2 *a—e*. |
| — | — | Forbes, in Morris's Catalogue of British Fossils, 2d ed., p. 82. |
| — | — | Desor, Synopsis des Échinides Fossiles, p. 193. |

Test small, oblong, much depressed; the single inter-ambulacrum produced into a caudal prolongation; mouth very near the anterior border; apical disc and vertex excentral; anterior border rounded and elevated, the posterior produced, and truncated.

*Dimensions.*—Height, nine tenths of an inch; antero-posterior diameter, one inch and two tenths; transverse diameter, one inch and one tenth. The great majority of the specimens, however, have the following measurement: Height, seven twentieths of an inch; antero-posterior diameter, fifteen twentieths of an inch; transverse diameter, thirteen twentieths of an inch.

*Description.*—The test of this elegant little urchin has an oblong shape, rounded and elevated before, produced and truncated posteriorly, and having the mouth and apical disc excentral, placed much nearer the anterior than the posterior border; the surface of the plates is covered with very small tubercles, which require the aid of a good lens to discover; without this the observer might suppose the test was altogether destitute of sculpture (fig. 2 *a, b*); in consequence of the excentricity of the mouth opening and disc, the single and antero-lateral ambulacral areas are straight and short, and terminate at the anterior border of the disc (fig. 2 *a*); the posterior pair are one seventh longer than the anterior pair; they curve upwards, inwards, and forwards on the dorsal surface, and terminate by the margin of the longitudinal valley, at a short distance from the posterior border of the disc (fig. 2 *a*).

The poriferous zones are narrow; the pores are situated some distance apart on the dorsal portion of the zones, and much wider apart at their basal region (fig. 2 *b, f*).

The inter-ambulacral areas are of unequal width; the anterior pair are the shortest and narrowest, the posterior pair the widest, and the single area the longest; it is likewise considerably produced into a lip-like process, which curves gently downwards, and is abruptly truncated posteriorly (fig. 2 *a, b*); the anterior and posterior pairs of the inter-ambulacral, and all the ambulacral areas, are convex on the upper surface; but the single inter-ambulacrum is traversed superiorly by a deep, broad, longitudinal valley, with

vertical and parallel walls in the upper part, gradually expanding into two ridges at the lower half, and which form the lateral boundaries of the anal valley (fig. 2 *a*).

The anterior border is bluntly rounded (fig. 2 *f*), with a slight depression in the middle, formed by the single ambulacral area; the base is concave, and slightly undulated (fig. 2 *c*), in consequence of the basal portions of the inter-ambulacral areas being convex, and those of the ambulacral forming straight valleys between them (fig. 2 *b*). The small mouth opening is sub-pentagonal, and (fig. 2 *b*) situated near the anterior third; the peristome is undulated, and the inter-ambulacral are smaller than the ambulacral lobes; the tubercles at the base are larger than those on the dorsal surface; they are likewise fewer in number, and arranged with much irregularity on the plates (fig. 2 *b*).

The apical disc is fortunately preserved in one of my specimens (fig. 2 *d*); it is formed of two small anterior ovarial plates, and two larger posterior ovarials; the right anterior plate supports the spongy madreporiform body; between the posterior ovarials the single imperforate ovarial is situated, composed of two pieces, an anterior and a posterior half (fig. 2 *h*). This arrangement of the genital plates is common to all the *Hyboclypi* with preserved discs I have examined; I have therefore noted it as a character common to the genus. The five ocular plates are small, and wedged between the depressions formed by the ovarials; their eye-holes are marginal, whilst the perforations in the ovarials are situated near the border.

The tubercles are small and numerous, each plate having three or four concentric rows arranged in diagonal lines on its surface (fig. 2 *g*). As the dorsal portion of this pretty little urchin varies considerably, I have given outlines in figs. *c*, *f*, *i*, *k*, of some of the most remarkable deviations from what I consider as the typical form, fig. 2 *d*.

*Affinities and differences.*—*Hyboclypus caudatus* differs from the other Oolitic species in its more oblong form, and especially in having the single inter-ambulacrum developed into a kind of caudate process; by this character it is readily distinguished from *H. gibberulus*, Agassiz, and *H. ovalis*, Wright, which it otherwise resembles; the mouth and vent are likewise placed nearer the anterior border than in these allied forms. The suborbicular shape which *H. agariciformis* invariably retains throughout its numerous varieties of elevation and depression of the upper surface readily distinguish it from all the forms of *H. caudatus* I have met with.

*Locality and Stratigraphical position.*—This is rather a rare urchin. I have found it occasionally in the upper beds of the Inferior Oolite, "the Gryphæa Grit" of Leckhampton, Birdlip, Shurdington, and Ravensgate Hills, associated with *Gryphæa sublobata*, Desh., *Lima pecteniformis*, Scloth., *Myopsis punctata*, Buck., *Cercomya rostralis*, Wright, *Terebratula impressa*, V. Buch. It occurs likewise in the Trigonia Grit at Hampen, associated with *Ammonites Parkinsoni*, Sow., and the numerous other Mollusca and Echinida which characterise that rich zone of life.

It is found occasionally in the planking beds of the Great Oolite at Minchinhampton Common. The Great Oolite specimens, however, are small, and not well preserved. M. Deslongchamps kindly communicated a specimen which he collected from the "Oolite ferrugineuse de Bayeux." On the ticket which accompanied it was written, "Seul exemplaire que j'ai trouvé," so that it is extremely rare in Normandy. This urchin very much resembled our small common examples from the Inferior Oolite. I know it from no other foreign locality.

HYBOCLYPUS GIBBERULUS, *Agassiz*. Pl. XXI, fig. 2 *a*, *b*, *c*, *d*, *e*, *f*, *g*.

| | | |
|---|---|---|
| HYBOCLYPUS GIBBERULUS. | | Agassiz, Échinodermes Fossiles de la Suisse, part i, p. 75, pl. 13, figs. 10—12. |
| — | — | Desor, Monographie des Galérites, p. 84, pl. 13, figs. 12—14. |
| — | — | D'Orbigny, Prodrome de Paléontologie, tom. i, p. 290, étage 10$^{e}$, Bajocien. |
| — | — | Bronn, Lethaea Geognostica, 3$^{e}$ Aufl., tabl. 17$^{1}$, fig. 11. |
| — | — | Agassiz and Desor, Catalogue raisonné, Annales des Sciences Naturelles, tom. vii, p. 152, série 3$^{e}$. |
| — | — | Desor, Synopsis des Échinides Fossiles, tabl. 26, figs. 11—13, p. 192. |
| NUCLEOLITES EXCISUS. | | Quenstedt, Handbuch der Petrefactenkunde, tabl. L, fig. 3, p. 585. |

Test oblong, elevated above, and contracted on the sides before; enlarged, depressed, produced, and truncated behind; single ambulacral area the highest, and, with the antero-lateral inter-ambulacral areas, form a gibbous crest; longitudinal valley wide and deep; single inter-ambulacrum slightly produced, deflected, and truncated; base much undulated, a depression in the anterior border; apical disc elongate, nearly central, but not vertical; vent very wide, opening at the inner extremity of the valley; mouth opening small, oblong, sub-central, near the anterior border.

*Dimensions.*—Height, nearly one inch; transverse diameter, two inches and one tenth of an inch; antero-posterior diameter, two inches and one tenth of an inch.

*Description.*—This urchin has so singular a form, that when once seen, it is not likely to be mistaken for any other, being remarkable for a prominent gibbous crest (fig. 2 *d*, *e*), which rises from the anterior half of the test, formed by the elevation of the single ambulacral area, and the two anterior inter-ambulacral areas; from the anterior border to the mouth a depression extends (fig. 2 *b*, *d*); the anterior lateral are more contracted than the posterior lateral borders (fig. 2 *a*, *b*); the posterior half of the test

is less elevated than the anterior half (fig. 2 *e*), and gradually declines from the vertex to the posterior border, which is a little produced and truncated (fig. 2 *a*, *b*).

The ambulacral areas are of unequal width; the single area is the narrowest, the anterior pair are a little wider, and the posterior pair are the widest; the single area makes a straight line from the mouth to the vertex; its upper half forms the ridge of the anterior gibbous crest (fig. 2 *d*); where it turns round the border a depression is formed, both there and at the base (fig. 2 *b*, *d*), by the bulging out of the inter-ambulacra; the anterior pair, between the border and the disc, are gently curved backwards (fig. 2 *e*), and the posterior pair are sinuous (fig. 2 *a*); the single and anterior pair terminate around the front of the disc (fig. 2 *a*), which is elongated in the longitudinal direction; the posterior pair terminate in the large specimen (fig. 2 *a*) within the longitudinal valley, one quarter of an inch behind the anterior pair; in each area there are six rows of tubercles, arranged so that they form oblique V-shaped lines (fig. 2 *f*).

The poriferous zones are narrow, and, from the border to the disc, the pores are placed close together, whilst, from the border to the mouth, they are wide apart (fig. 2 *a*); this arises from the ambulacral plates on the dorsal surface being narrow, whilst those at the base are broad; there are six pairs of pores opposite each of the large fourteen plates on the upper surface, which makes eighty-four pairs of pores on the dorsal portion of the zones, whilst there are only about fifteen pairs of pores in the base.

The inter-ambulacral areas are of unequal width; the anterior pair are the narrowest; the posterior pair are one third wider than the anterior, and the single inter-ambulacrum is the widest (fig. 2 *a*); the middle of its dorsal portion is occupied by the longitudinal valley, which is wide and deep above, and shallow and expanded below; the small and numerous tubercles are arranged very closely and regularly together in four or five concentric rows (fig. 2 *f*); and I have counted upwards of one hundred tubercles on one large plate near the margin.

The tubercles are very numerous at the border and external third of the base, whilst they are fewer, larger, and less regular between that point and the mouth; they are all perforated, and raised on low, crenulated bosses, surrounded by sunken circular areolas (fig. 2 *g*); the inter-tubercular surface of the plates is likewise covered with close-set miliary granules (fig. 2 *g*).

The base is concave, and much undulated (fig. 2 *b*, *c*), the basal portions of the inter-ambulacra being very convex (fig. 2 *d*), whilst the ambulacra lie in narrow valleys between them; the small mouth opening is sub-central, and situated nearer the anterior border, almost opposite to the vertex (fig. 2 *b*); the peristome has a sub-pentagonal form, but its minute structure is more or less concealed in all my specimens.

The apical disc is nearly central; it lies behind the summit of the crest, which rises above it (fig. 2 *e*), so that the vertex is before the disc in this remarkable species; it has a narrow, elongated form, and is composed of six ovarial and five ocular plates (fig. 2 *e*

gives a faithful representation of the disc); the anterior are smaller than the posterior ovarials; the right is larger than the left plate, and supports, as usual, a spongy madreporiform body; the posterior ovarials are large and elongated, and separated from the anterior pair by the excessive development of the anterior pair of ocular plates, which form an important part of the disc; the large oviductal holes always indicate the true relative position of the genital plates; the single imperforate ovarial is composed of two plates, placed end to end, and behind the posterior ovarials the posterior pair of ocular plates are placed. M. Desor's figure of the disc of this species does not agree with our specimens, as the single imperforate ovarial, which is central and double, is entirely wanting in his figure, probably through an oversight on the part of the artist. I have verified Mr. Bone's beautiful drawing in three different individuals by a careful examination with the lens.

*Affinities and differences.*—This remarkable urchin, which formed the type of the genus, is so well characterised by its gibbous crest that it cannot be mistaken for any other species. *H. ovalis* has a considerable resemblance to it; but the absence of the crest, its oval form, and the want of those prominent traits which distinguish *H. gibberulus*, clearly distinguish them from each other.

*Locality and Stratigraphical position.*—I have collected this species in the upper beds of the Inferior Oolite, in the zone of *Ammonites Parkinsoni*, Sow., at Burton Bradstock, and Walditch Hill, near Bridport, Dorset; a few specimens have been found in the Inferior Oolite in the parish of Charlcomb, near Bath. The Dorsetshire specimens were associated with *Holectypus hemisphæricus*, Desor, *Stomechinus bigranularis*, Lamk., *Clypeus altus*, M'Coy, *Collyrites ringens*, Agass., *Terebratula sphæroidalis*, Sow., *Rhynchonella plicatella*, Sow., *Terebratula Phillipsii*, Mor., *Ammonites Parkinsoni*, Sow., *Ammonites sub-radiatus*, Sow.

It appears to be a rare species on the Continent. M. Desor observes, "Suivant les indications que m'a fournies M. Gressly, on la trouve dans une couche particulière de l'Oolite inférieure, la marne à *Ostrea acuminata*, la même qui contient aussi *Discoidea* (*Holectypus*) *depressa*, et le *Dysaster analis*, c'est au moins dans cette couche que l'a rencontrée M. Strohmeyer."* In his 'Synopsis des Échinides Fossiles,' M. Desor gives, as the other foreign localities of this species, "Vesulien (Marnes à Discoidées du Jura Soleurois et Argovien, du Hummel, près Waldenburg. Grande Oolite de Macon (Hébert), du départ. de l'Ain."

M. De Loriére has sent me a specimen which he collected at "Nogent, étage Callovien, département de la Sarthe;" and from M. Sæmann I have received another from the étage Callovien of the same department. I have already expressed a doubt as to the age

* 'Monographie des Galérites,' p. 85.

of the beds which have yielded *Hyboclypus gibberulus*, *Pygurus depressus*, and *Collyrites ringens*, in the department of the Sarthe; my friend M. Cotteau is at this moment engaged on a work on the Echinoderms of that department, and my friend M. Triger has undertaken a review of the stratigraphical distribution of the species. From this monograph we shall therefore learn the true age and position of these strata.

*History.*—This species was first figured and described by M. Agassiz, in his 'Échinodermes Fossiles de la Suisse,' he only knew two specimens from the Inferior Oolite of Switzerland. It was afterwards figured by M. Desor in his valuable 'Monograph on the Galerites,' and was described by me as a British fossil for the first time.* It has lately been figured by M. Bronn in his 'Lethaea Geognostica,' and by M. Desor in his 'Synopsis des Échinides Fossiles.'

HYBOCLYPUS OVALIS, *Wright*, nov. sp. Pl. XXII, fig. 1 *a*, *b*, *c*, *d*, *e*, *f*.

Test oval or suborbicular, upper surface convex, rather more elevated anteriorly; ambulacral areas narrow, nearly of equal width; the single and anterior pair straight; posterior pair curved gently upwards, inwards, and forwards; apical disc small, nearly central, rather nearer the anterior border; longitudinal valley of moderate width and depth; base concave and undulated, from the convexity of the basal inter-ambulacra; mouth opening small, excentral, nearer the anterior than the posterior border.

*Dimensions.*—Height, seven tenths of an inch; transverse diameter, one inch and eleven twentieths; antero-posterior diameter, one inch and thirteen twentieths.

*Description.*—This species very much resembles *H. gibberulus*, but it wants the striking features of that urchin; the contracted anterior border, expanded posterior border, wide anal valley, and prominent gibbous crest are absent; although in the minute structure of the test there is much resemblance between them. It is collected, moreover, from the same stratigraphical horizon, the zone of *Ammonites Parkinsoni*, Sow., and may be regarded as the representative of *H. gibberulus* in the Cotteswold Hills, as that species, so far as I know, has never yet been found in this district.

The test is in general oval, but it has sometimes a sub-orbicular shape (fig. 1 *a*). The upper surface is very uniformly convex, and the anterior part is rather more elevated than the sides (fig. 1 *c*); most *Hyboclypi* manifest a disposition to the formation of

* 'Annals and Magazine of Natural History,' 2d series, vol. ix, p. 120.

an anteal elevation of the test, which attains its greatest development in *H. gibberulus*. (See fig. 2 *f*, *k*.)

The ambulacral areas have all nearly a uniform width; the single and anterior pair are nearly straight, and converge around the front part of the disc (fig. 1 *a*); the posterior pair are a little bent, and curve upwards, inwards, and forwards, to terminate at the posterior lateral part of the disc, their apices just falling within the longitudinal valley.

The apical disc is large, and formed of seven ovarial and five ocular plates; the two pairs of ovarials are perforated; the single plate is imperforate, and composed of three pieces (fig. 1 *e*); the pairs of ovarials expand between the apices of the ambulacra, and the posterior elements of the single plate bend over the upper part of the longitudinal valley (fig. 1 *a*); the madreporiform body is round, button-shaped, and placed between the anterior and the right antero-lateral ambulacra; it therefore rests on the surface of the right ovarial plate, as in other Echinidæ. The single ocular plate is small; the anterior pair are large, and placed side by side in the centre of the disc, between the anterior and posterior pairs of ovarials; but the posterior oculars are not seen *in situ* in any of my specimens.

The base is concave, and much undulated, from the convexity of the basal portions of the inter-ambulacral areas; the mouth opening is small and excentral, it has an oval form, its long diameter being in the direction of the antero-posterior diameter of the body; around the border of the opening the poriferous zones become closely crowded with pores, which lie in triple oblique pairs, and form a radiate rosette around the orifice. These areas are well seen in fig. 1 *b*, and a portion of one of them, magnified, is drawn in fig. 1 *f*, where each of the broad plates are seen to be perforated with a pair of pores, having one, two, or three large tubercles on their surface.

There are four or five rows of small tubercles, so arranged on the plates that they form, as in most of the Echinoconidæ, oblique V-shaped lines (fig. 1 *d*). The poriferous zones are narrow, and on a level with the general surface of the test; the pores are placed close together on the dorsal surface, there being six pairs of pores opposite one inter-ambulacral plate; at the base they are wide apart, from the increased breadth of the ambulacral plates in this region (fig. 1 *b* and *f*).

The inter-ambulacral areas are five or six times the width of the ambulacral (fig. 1 *a* and *b*); they are, however, of unequal width; the anterior pair are the narrowest, the posterior are wider, and the single area is the widest; in its upper part is the longitudinal valley, which is very deep above, with vertical walls, that expand in the lower half, and form a concave depression (fig. 1 *a*); the posterior border, which is very little produced, is rounded, or only slightly flattened (fig. 1 *a* and *b*), and not truncated, as in *H. caudatus* and *H. gibberulus*. The tubercles are small, and very numerous (fig. 1 *d*); they are arranged in concentric rows, and I have counted fifty tubercles on the third plate, above the border; they are surrounded by sunken areolas, and the inter-

tubercular surface is crowded with small granules; the tubercles in both areas are of the same size.

*Affinities and differences.*—This urchin in its general *facies* bears so much resemblance to *H. gibberulus*, Agass., that at one time I considered it a variety of that species; but the absence of the gibbous crest, the fulness of the anterior border, the straightness of the anterior ambulacra, the form and direction of the posterior pair, together with the difference observed in the shape of the longitudinal valley, have induced me to separate it from that species under the name *H. ovalis*. By its oval shape and elongated apical disc it is distinguished from *H. agariciformis*, and by the shortness of the single inter-ambulacrum from *H. caudatus*.

*Locality and Stratigraphical position.*—I have collected this species only from the marly fossiliferous vein which traverses the upper ragstones of the Inferior Oolite, in the zone of *Ammonites Parkinsoni*, Sow., near Hampen, Gloucestershire, where it is associated with *Holectypus depressus*, Leske, *H. hemisphæricus*, Desor, *Pedina rotata*, Wright, *Clypeus Hugi*, Agass., *Clypeus Plottii*, Klein, *Trigonia costata*, Sow., *Pectin symmetricus*, Morris, *Ammonites Parkinsoni*, Sow. I have found one specimen in the Trigonia bed at Cold Comfort, where it was associated with the large *Perna isognomonoides*, Stahl.

## B. *Species from the Coral Rag.*

### Hyboclypus stellatus, *Desor.*

| | | |
|---|---|---|
| Hyboclypus stellatus. | | Desor, Catalogue raisonné Annales des Sciences Naturelles, 3ᵉ série, tome vii, p. 152. |
| — | — | Desor, Synopsis des Échinides Fossiles, p. 193. |
| — | marcou. | D'Orbigny, Prodrome de Paléontologie, tome ii, p. 26. |

This urchin is described by M. Desor as "Espèce intermédiaire par sa forme, entre les *H. canaliculatus* et *H. Marcou*, mais différant de l'un et de l'autre par ses ambulacres postérieurs qui sont rectilignes au lieu d'être arqués. T. 76 (type du l'espèce).

"*Formation.*—Corallien du Wiltshire. Rare.

"*Collection.*—M. le Viscomte d'Archiac."

I only know this species from the above notice, as I have never been so fortunate as to see a specimen of it in any of the collections of Coral-rag urchins which I have examined.

## PLATE XI.

*Hemipedinas from the Coral Rag.*

Fig.

1 *a*. Hemipedina Marchamensis, *Wright*, p. 161. Base of the test, natural size.

*b*. One inter-ambulacral plate, a portion of the ambulacral area, and poriferous zones, magnified twice.

*c*. Lateral view of a primary tubercle, showing its prominent boss, with smooth summit.

2 *a*. Hemipedina tuberculosa, *Wright*, p. 164. Upper surface of the test, natural size.

*b*. Base of the test, natural size.

*c*. Lateral view of the test, natural size.

*d*. Two inter-ambulacral plates, a portion of the ambulacral area, and poriferous zones, magnified three times.

*e*. Lateral view of a primary tubercle, showing the prominent boss, with its smooth summit, and the scrobicular granules encircling the areola.

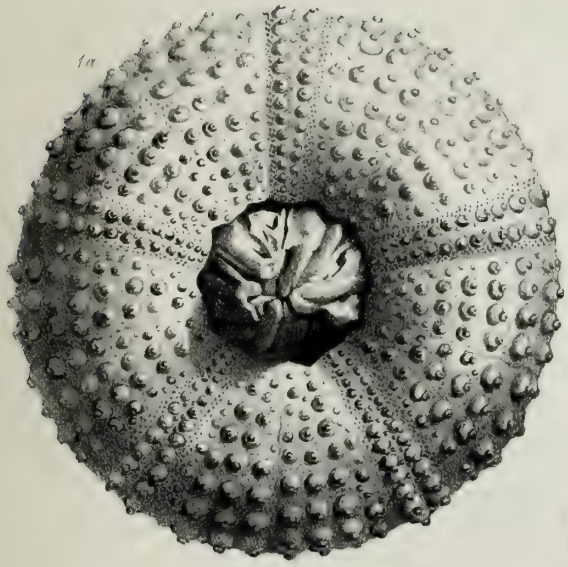
*f*. A primary spine, magnified three times.

*Hemicidaris from the Great Oolite.*

3 *a*. Hemicidaris Bravenderi, *Wright*, p. 84. Test and spines *in situ*, on a slab of Great Oolite from Stratton, near Cirencester.

*b*. A primary spine, magnified three times.

*c*. Base of a spine, showing the crenulated rim of its acetabulum and the milled ring.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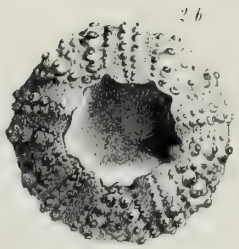
2a

2f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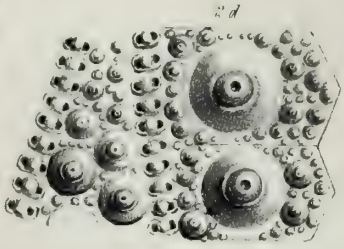
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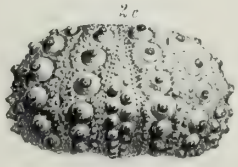
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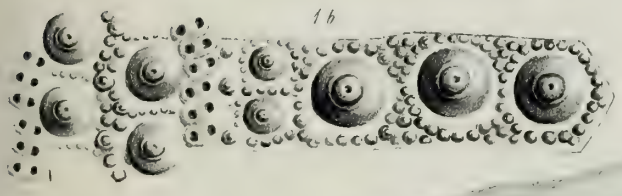
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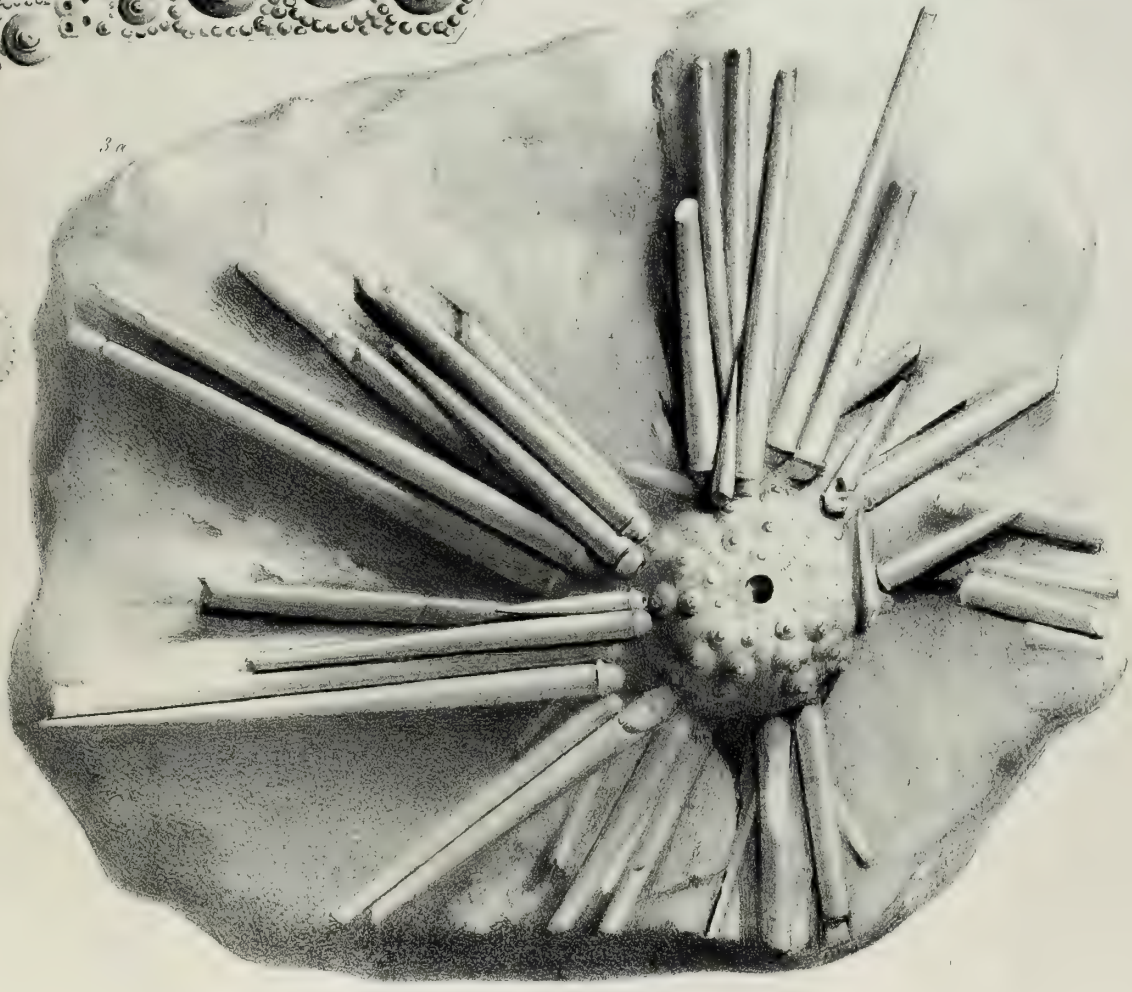
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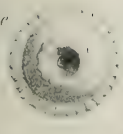
3c

3b

C R Bone, del et lith.

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# PLATE XII.

*Hemipedinas from the Great Oolite, Coral Rag, and Kimmeridge Clay.*

Fig.

1 *a*. Hemipedina Corallina, *Wright*, p. 163. Portion of the base and jaws *in situ*.
*b*. Fragment, with plates and spines, from the Coral Rag, Wilts.
*c*. One inter-ambulacral plate, magnified three times.
*d*. A primary spine, from fragment *b*, magnified three times.

2 *a*. Hemipedina Morrisii, *Wright*, p. 166. A fragment of the test, natural size.
*b*. Ambulacral area, poriferous zones, and inter-ambulacral plates, magnified four times.
*c*. A primary spine, magnified four times.

3 *a*. Hemipedina Cunningtoni, *Wright*, p. 167. A fragment of the test, natural size.
*b*. The same, magnified four times.

4 *a*. Hemipedina microgramma, *Wright*, p. 159. Upper surface of the test, natural size.
*b*. A lateral view of the test, natural size.
*c*. One inter-ambulacral plate, a portion of the ambulacra, and poriferous zones, magnified four diameters.

4.* Cidaris spinosa, *Agassiz*, p. 53. Spine, natural size.

5 *a*. Cidaris Boloniensis, *Wright*, p. 53. A flattened spine with prickly ridges.
*b*. A spine with thorny prickles, resembling *C. spinosa*.

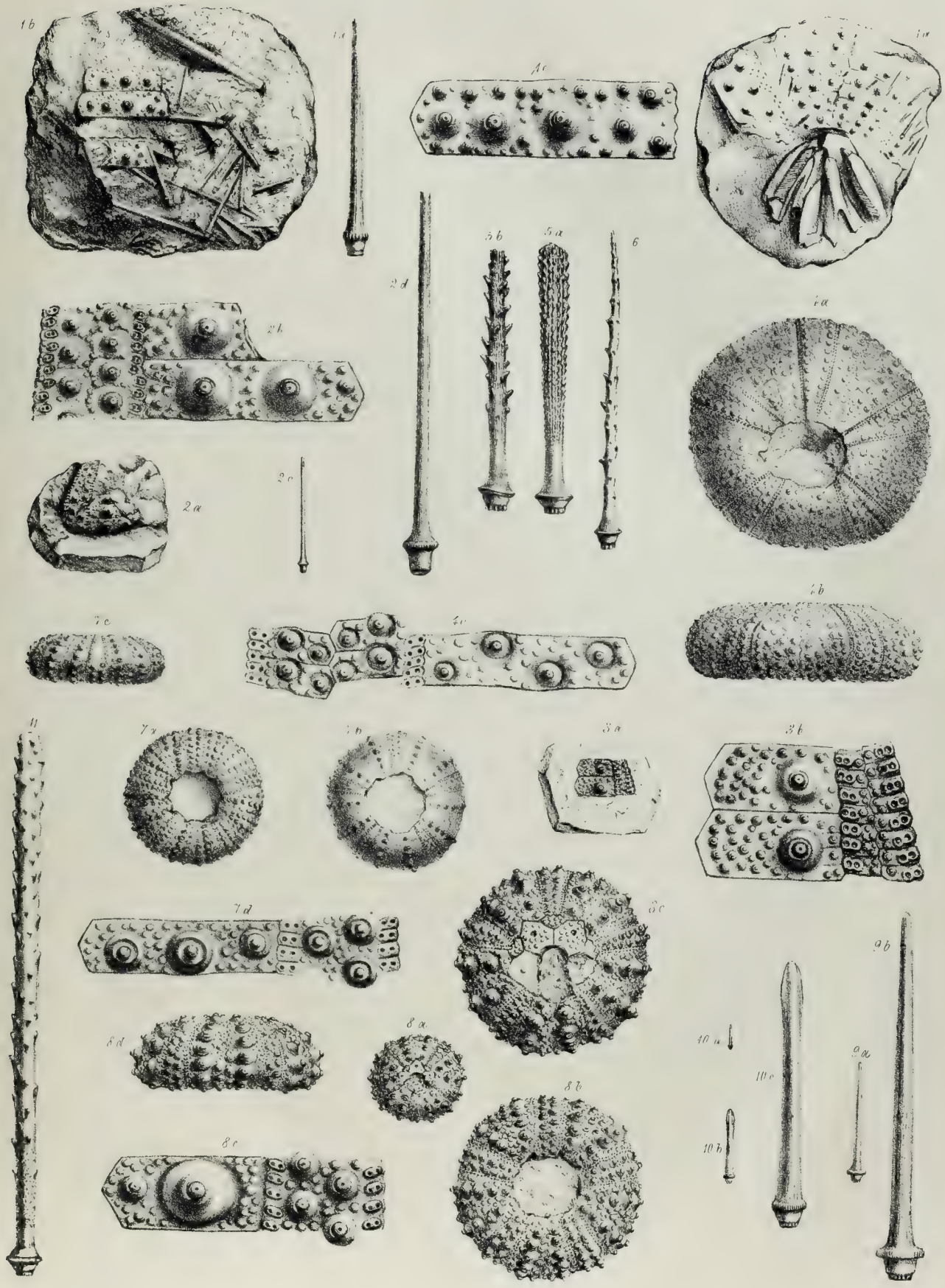
6 *a*. Hemipedina Davidsoni, *Wright*, p. 156. A lateral view of the test, natural size.
*b*. The upper surface of the test, natural size.
*c*. The under surface of the test, natural size.
*d*. One inter-ambulacral plate, a portion of the ambulacra, and poriferous zones; magnified six diameters.

7 *a*. Hemipedina Woodwardi, *Wright*, p. 158. A lateral view of the test, magnified twice.
*b*. Upper surface of the test, magnified twice.
*c*. Under surface of the test, magnified twice.
*d*. One inter-ambulacral plate, ambulacra, and poriferous zones, magnified six times.

8. Pseudodiadema mammillanum, *Roemer*, p. 132. Primary spine, magnified three times.

9. Pseudodiadema versipora, *Phillips*, p. 124. Primary spine, magnified three times.

10. Rabdocidaris maxima, *Münster*, p. 65. Primary spine, natural size.

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# PLATE XIII.

*Pedinas from the Inferior Oolite.*

Fig.

1 *a*. Pedina rotata, *Wright*, p. 173. Base of the test, natural size.
*b*. Upper surface of the test, showing the apical disc, natural size.
*c*. Lateral view of the test, natural size.
*d*. Apical disc, magnified two and a half diameters.
*e*. Inter-ambulacral plate, ambulacral area, and poriferous zones, magnified four times.

2 *a*. Pedina Smithii, *Forbes*, p. 176. Fragment of the test, natural size.
*b*. Inter-ambulacral plate, ambulacral area, and poriferous zones, magnified three times.
*c*. Lateral view of another specimen, showing the ambulacral and inter-ambulacral areas.

*Glypticus from the Coral Rag.*

3 *a*. Glypticus hieroglyphicus, *Goldfuss*, p. 186. Under surface of the test, natural size.
*b*. Upper surface, natural size.
*c*. Lateral view, natural size.
*d*. Apical disc, magnified two and a half times.
*e*. One of the large primary tubercles, magnified two and a half times.
*f* Two inter-ambulacral plates, showing the sculpture, ambulacra, and zones, magnified four times.

*Polycyphus from the Inferior Oolite.*

4 *a*. Polycyphus Normannus, *Desor*, p. 196. Test, upper surface, natural size.
*b*. Upper surface, magnified once and a half.
*c*. Under surface, showing the mouth opening and peristome, magnified once and a half.
*d*. Apical disc, magnified four times.
*e*. Lateral view of the test, magnified once and a half.
*f*. Inter-ambulacral and ambulacral areas, showing the arrangement of the tubercles, magnified six times.

5 *a*. Polycyphus Deslongchampsii, *Wright*, p. 199. Test, upper surface, natural size.
*b*. Upper surface, with the apical disc, magnified twice.
*c*. Under surface, with the mouth and peristome, magnified twice.
*d*. Lateral view, magnified twice.
*e*. Apical disc, magnified twice.
*f*. Inter-ambulacral and ambulacral areas, showing the arrangement of the tubercles, magnified six times.

## PLATE XIII (*continued*).

*Magnotia from the Inferior Oolite.*

Fig.

6 *a*. Magnotia Forbesii, *Wright*, p. 191. Upper surface of the test, natural size.

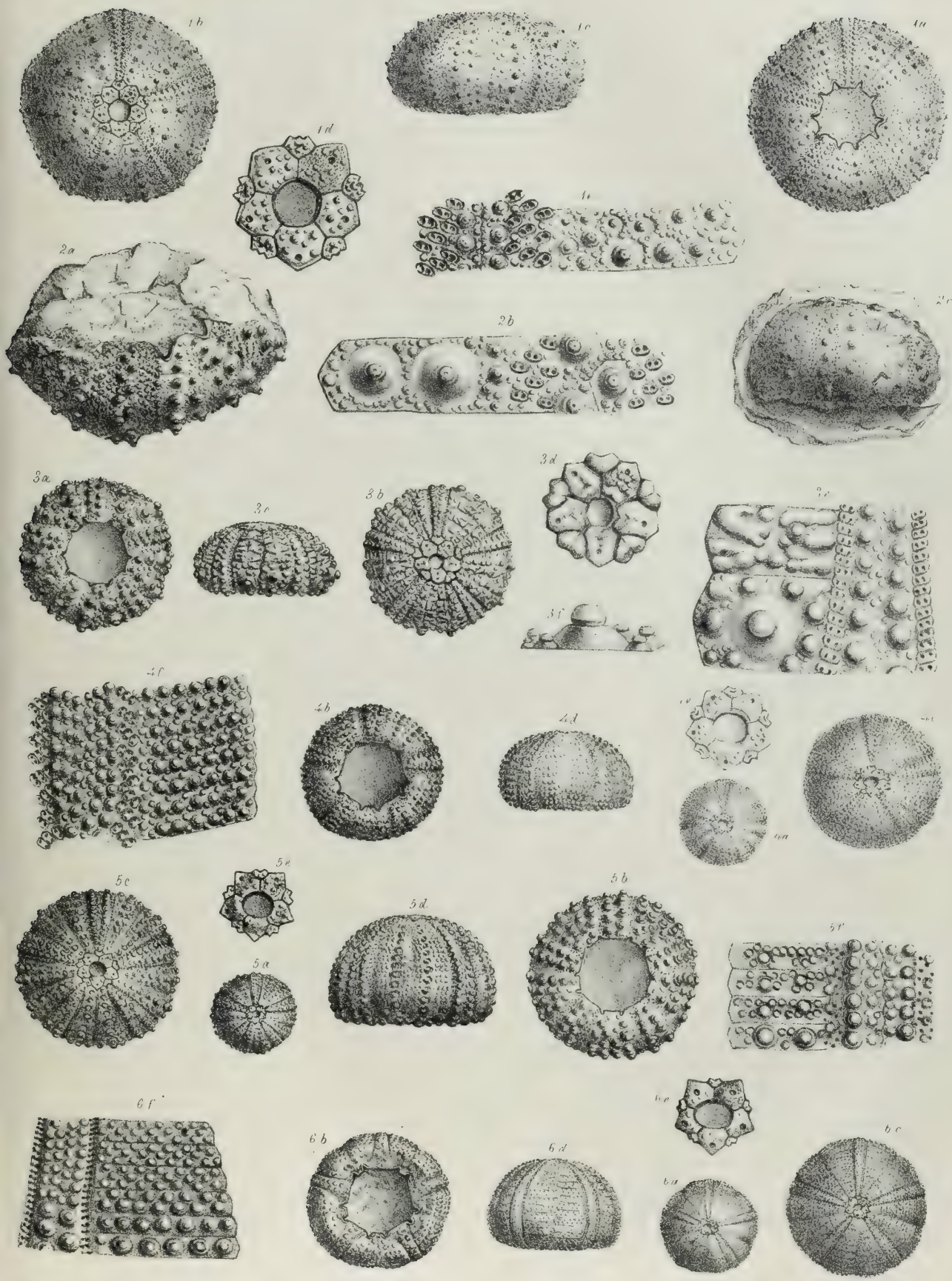
*b*. Upper surface of the test, magnified once and a half.

*c*. Under surface of the test, magnified once and a half.

*d*. Lateral view of the same, magnified once and a half.

*e*. Apical disc, magnified four times.

*f*. Inter-ambulacral and ambulacral plates, with the poriferous zones, showing the arrangement of the tubercles and the unigeminal disposition of the pores.

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# PLATE XIV.

*Stomechini from the Inferior Oolite.*

Figs.

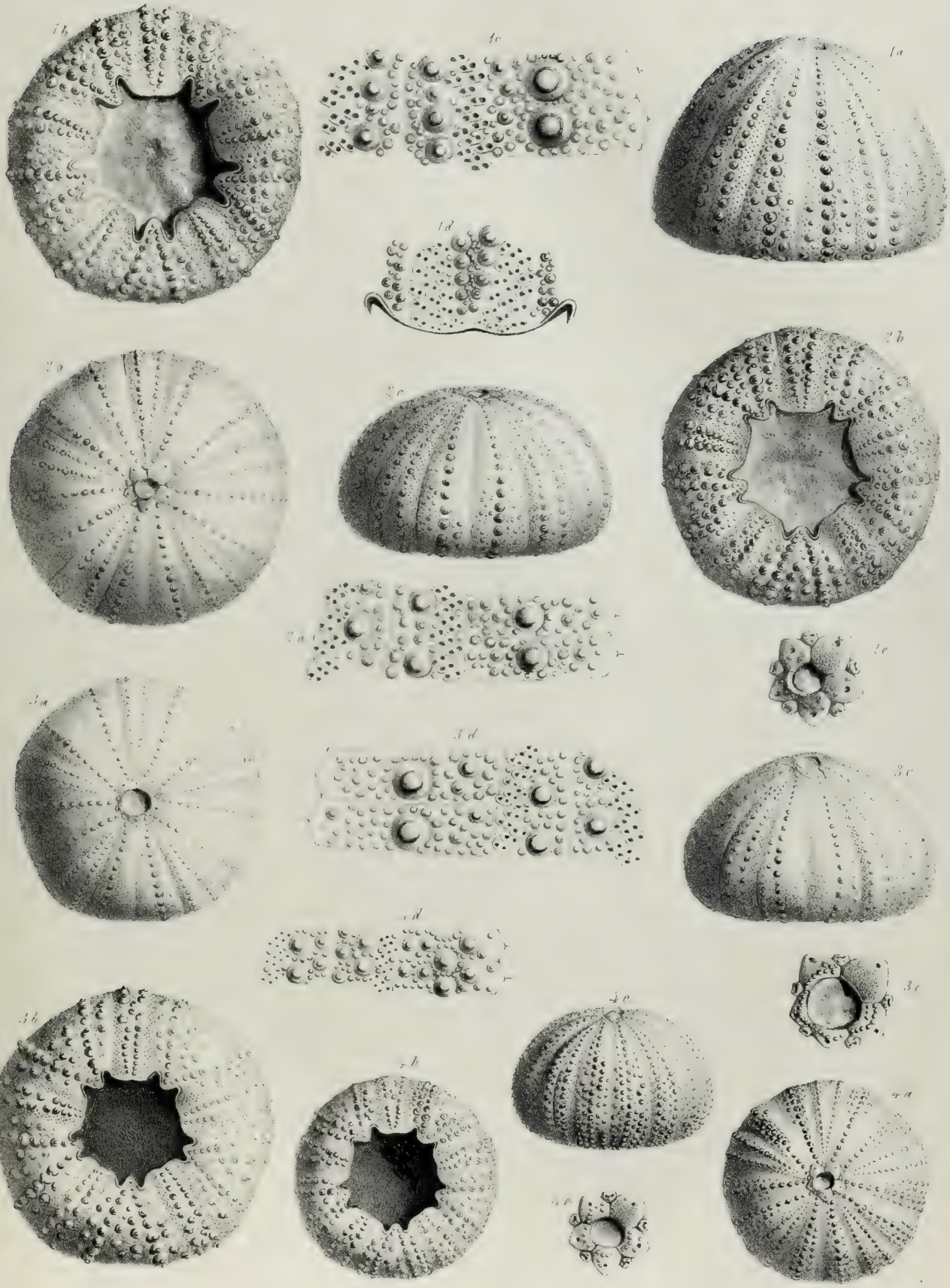
1 *a*. STOMECHINUS GERMINANS, *Phillips*, p. 204. Lateral view of the test, natural size.
*b*. Base of the test, showing the wide mouth opening and deeply notched peristome.
*c*. Ambulacral area, poriferous zones, and two inter-ambulacral plates, magnified three times.
*d*. Base of an inter-ambulacral area, showing the arrangement of the ranks of pores, magnified three times.

2 *a*. STOMECHINUS INTERMEDIUS, *Agassiz*, p. 208. Upper surface of the test, natural size.
*b*. Base of the test, showing the mouth opening and peristome, natural size.
*c*. Lateral view of the same, natural size.
*d*. Ambulacral area, poriferous zones, and two inter-ambulacral plates, magnified three times.
*e*. Apical disc, magnified two diameters.

3 *a*. STOMECHINUS BIGRANULARIS, *Lamarck*, p. 210. Upper surface of the test, natural size.
*b* Base of the test of a larger specimen, showing the small mouth opening, natural size.
*c*. Lateral view of *a*, showing the excentral apical disc.
*d*. Ambulacral area, poriferous zones, and two inter-ambulacral plates, magnified three times.
*e*. Apical disc, magnified two diameters.

*Stomechinus from the Coral Rag.*

4 *a*. STOMECHINUS GYRATUS, *Agassiz*, p. 215. Upper surface of the test, natural size.
*b*. Base of the test, showing the mouth opening and peristome, natural size.
*c*. Lateral view of the same, showing the tubercular inter-ambulacra, natural size.
*d*. Ambulacral area, poriferous zones, and inter-ambulacral plates, magnified three times.
*e*. Apical disc, magnified two diameters.




J.R Bone del et lith

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## PLATE XV.

*Stomechini from the Great Oolite and Coral Rag.*

Fig.

1 *a*. Stomechinus microcyphus, *Wright*, p. 213. Lateral view of the test, natural size.

*b*. Two inter-ambulacral plates, a portion of an ambulacral area, and poriferous zones, magnified four times.

2 *a*. Stomechinus nudus, *Wright*, p. 217. Upper surface of the test, natural size.

*b*. Base of the test, natural size.

*c*. Lateral view of the test, natural size.

*d*. Two inter-ambulacral plates, a portion of an ambulacral area, with the poriferous zones, magnified four times.

*e*. Apical disc, magnified three diameters.

*Acrosalenias from the Lias and Cornbrash.*

3 *a*. Acrosalenia minuta, *Buckman*, p. 230. Test, the natural size. Lower Lias.

*b*. The upper surface of the same test, magnified four times.

*c*. Base of another specimen, natural size.

4 *a*. Acrosalenia hemicidaroides, *Wright*, p. 234. Upper surface of the test, natural size.

*b*. Base of the same test, natural size.

*c*. Lateral view of the same, natural size.

*d*. Two inter-ambulacral plates, a portion of an ambulacral area, with the poriferous zones, magnified three times.

*e*. Base of the ambulacral and inter-ambulacral areas, showing the trigeminal pores near the peristome, magnified three times.

*f*. Lateral view of a primary tubercle and its prominent boss, magnified three times.

*g*. Base of a small specimen, showing the mouth opening and jaws *in situ*.

*h*. One of the jaws of another specimen, magnified.

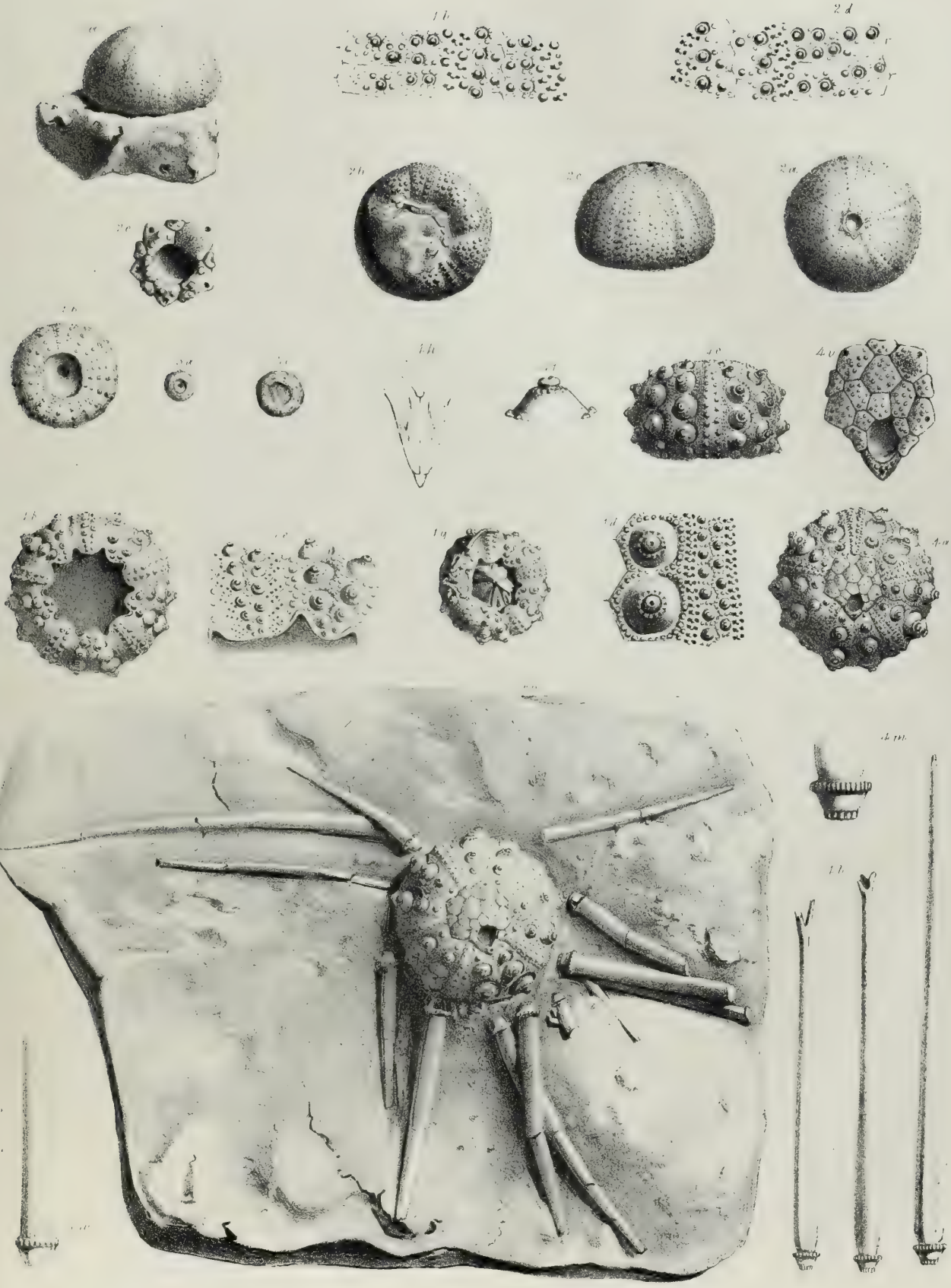
*i*. Apical disc complete, showing the compound sur-anal plate, magnified two diameters.

*k*. Test with spines *in situ*, on a slab of Forest Marble.

*l*. Three primary spines, showing their simple and trifid termination, natural size.

*m*. Base of a primary spine, showing the milled ring and head, magnified three times.

*n*. A secondary spine, natural size and highly magnified.



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# PLATE XVI.

*Acrosalenias from the Inferior and Great Oolite.*

Fig.

1 *a*. Acrosalenia Lycettii, *Wright*, p. 232. Upper surface of the test, natural size.
*b*. Under surface of the same, showing the wide decagonal peristome, natural size.
*c*. Lateral view of the same, showing both areas.
*d*. Two inter-ambulacral plates, a portion of an ambulacral area, with the poriferous zones, magnified three times.
*e*. Base of an ambulacral area, showing the trigeminal ranks of pores in this region, magnified three times.
*f*. A primary tubercle, with its prominent conical boss, highly magnified.

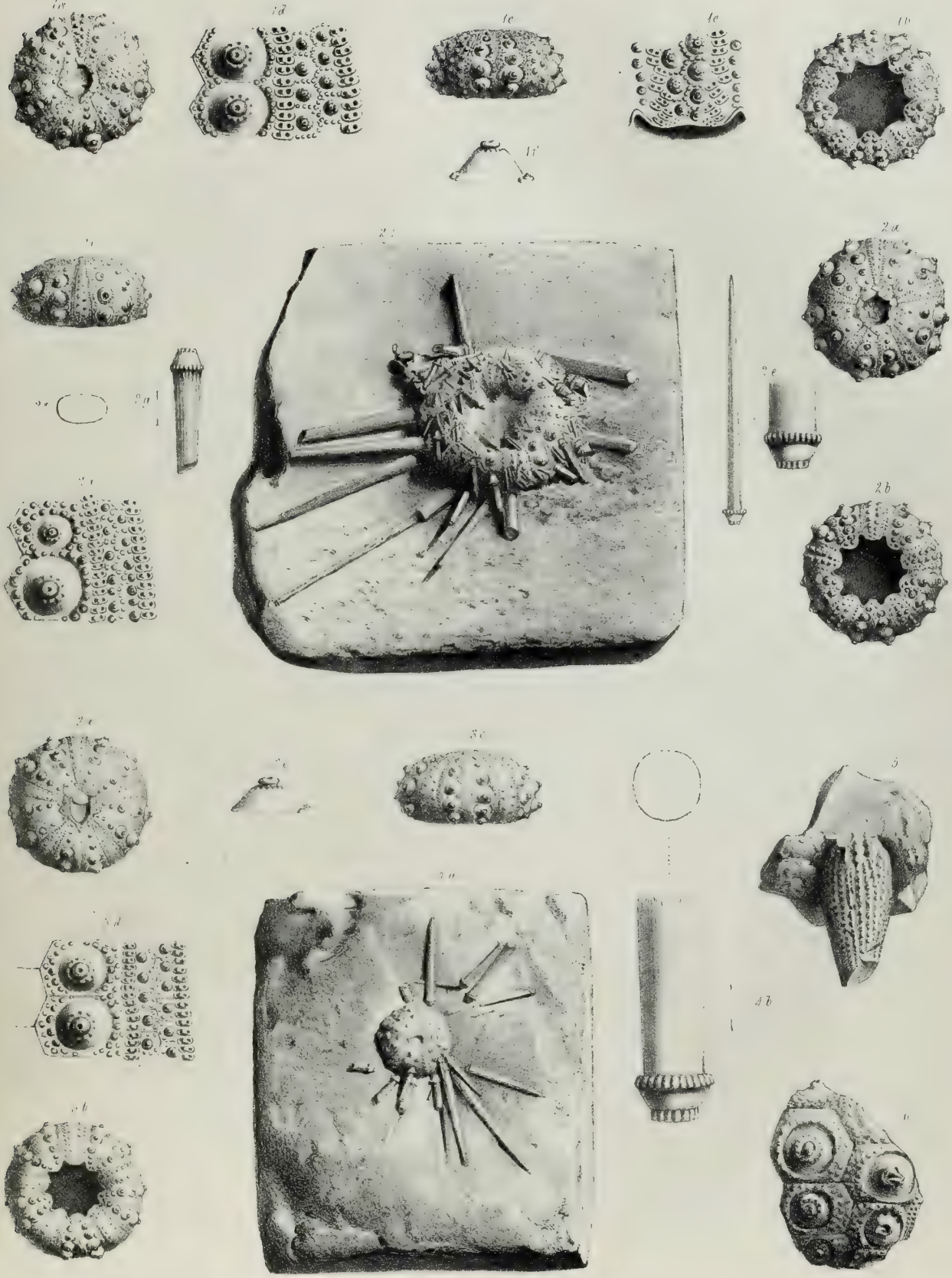
2 *a*. Acrosalenia pustulata, *Forbes*, p. 242. Upper surface of the test, natural size.
*b*. Under surface of the same, showing the wide decagonal peristome, natural size.
*c*. Lateral view of the same, showing the small ambulacral tubercles, natural size.
*d*. Two inter-ambulacral plates, a portion of an ambulacral area, with the poriferous zones, magnified three times.
*e*. A primary spine, natural size, and the base of the same, magnified three diameters.
*f*. The body and spines *in situ*, on a slab of Great Oolite, natural size.

3 *a*. Acrosalenia Wiltonii, *Wright*, p. 246. Upper surface of the test, natural size.
*b*. Under surface of the same, natural size, showing the narrow mouth opening.
*c*. Lateral view of the same, natural size, showing the wide miliary zone.
*d*. Two inter-ambulacral plates, a portion of an ambulacral area, and the poriferous zones, magnified three times.
*e*. A primary tubercle on its large prominent boss, magnified three times.

4 *a*. Acrosalenia Loweana, *Wright*, p. 240. Test and spines *in situ*, natural size, on a slab of Forest Marble.
*b*. One of the primary spines, magnified five times, with transverse section of the same.

5. Spine of Cidaris Yeovilensis, *Wright*.
6. Cidaris Moorei, *Wright*.

} These new species will be described in the Appendix.



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# PLATE XVII.

*Acrosalenias from the Lias, Cornbrash, and Coral Rag.*

Fig.

1 *a*. ACROSALENIA DECORATA, *Haime*, p. 247. Upper surface of the test, natural size.
*b*. Under surface of the test, natural size, showing the concave base and equal-lobed peristome.
*c*. Lateral view of the same, natural size, showing the magnitude of the equatorial tubercles.
*d*. Upper surface of the inter-ambulacral and ambulacral areas, magnified four times.
*e*. Two equatorial inter-ambulacral plates and a portion of the ambulacral area, magnified four diameters.
*f*. The apical disc, with all the elements of the sur-anal plate *in situ*, magnified three times.
*g*. The apical disc of another specimen, showing the single crescentic genital plate, magnified four times.
*h*. Base of the ambulacral and inter-ambulacral areas, with two lobes of the peristome, magnified four times.
*i*. Lateral view of an equatorial primary tubercle, with its highly crenulated boss.
*k*. Slab from the Coralline Oolite of Malton, with tests and spines *in situ*, natural size.
*l*. Primary spine, natural size, with base and transverse section, magnified four times.
*m*. Secondary spine, magnified, showing the longitudinal lines on its surface.

2 *a*. ACROSALENIA MINUTA, *Buckman*, p. 230. Test, the natural size.
*b*. Base of the same, magnified three diameters.
*c*. Upper surface of the same, magnified three diameters.
*d*. Lateral view of the same, magnified three diameters.
*e*. Two inter-ambulacral plates, a portion of an ambulacral area, and poriferous zones, magnified ten times.

3 *a*. ACROSALENIA SPINOSA, *Agassiz*, p. 238. Upper surface of the test, natural size.
*b*. Base of the same, natural size.
*c*. Lateral view of the same, natural size.
*d*. Two inter-ambulacral plates, a portion of the ambulacral area, and poriferous zones, magnified four times.
*e*. The conical boss, with its crenulated summit, and perforated tubercle, magnified.
*f*. The apical disc, with its single sur-anal plate, magnified four diameters.

## PLATE XVII (*continued*).

Fig.

4 *a*. Acrosalenia Loweana, *Wright*, p. 240. Upper surface of the test, natural size.

*b*. Lateral view of the test, natural size.

*c*. Two inter-ambulacral plates, a portion of the ambulacral area, and poriferous zones, magnified three diameters.

5. Acrosalenia Wiltonii, *Wright*, p. 246. The apical disc, magnified three times.

*Spines of unknown Species.*

6. Globular spine from the Great Oolite near Bath, magnified three times.

7. Spine from the Forest Marble of Upper Cubberly, near Cheltenham, natural size, and magnified three times.

8 Spine from the Great Oolite of Bath.

*a*. Spine ditto ditto.

9. Spine from the Stonesfield slate of Eyeford, Gloucestershire, and surface magnified five times.

10. Spine from the Stonesfield slate of Eyeford, Gloucestershire, and surface magnified four times.

11. Spine from the Great Oolite of Minchinhampton, natural size.

12. Spine from the Pea-grit, near Cheltenham, fragment natural size.

13. Spine from the Lower Lias of Bushley, near Tewkesbury, and a portion magnified five times.

14. Spine from the Lower Lias of Lyme Regis, and portion magnified four times.

15. Spine ditto ditto, and portion magnified five times.

16. Spine ditto ditto, and portion magnified three times.

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## PLATE XVIII.

*Holectypi from the Inferior Oolite and Cornbrash.*

Fig.

1 *a*. Holectypus depressus, *Leske*, p. 260. Upper surface, natural size.

*b*. The base, showing the mouth and anal openings, natural size.

*c*. A side view of the same test, natural size.

*d*. Ambulacral areas, poriferous zones, and inter-ambulacral plates, magnified three diameters.

*e*. Primary tubercle from the upper surface, with its circle of areolar granules, magnified seven times.

*f*. Primary tubercle from the base, magnified seven times.

*g*. Under surface of another specimen, showing the jaws *in situ*, natural size.

*h*. Portion of a primary spine, magnified eight times.

*i*. The apical disc, magnified three and a half times.

2 *a*. Holectypus hemisphæricus, *Agassiz*, p. 264. Upper surface, natural size.

*b*. Under surface, natural size.

*c*. Posterior view, showing the marginal anal opening.

*d*. Ambulacral area, poriferous zones, and three inter-ambulacral plates, magnified three diameters.

*e*. The apical disc, magnified three times.

*f*. Lateral view, showing the greater length of the posterior half.

*g*. A conical variety, showing the height of the pyriform marginal anal opening.

*h*. The base of a large specimen.

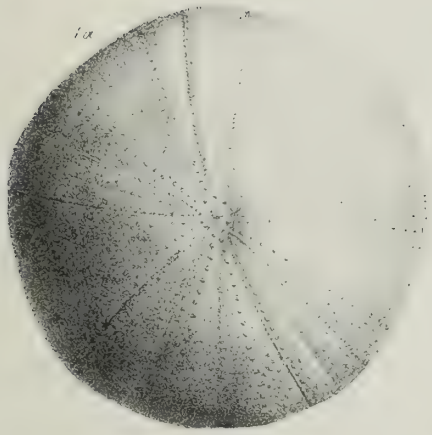
*Holectypus from the Coral Rag.*

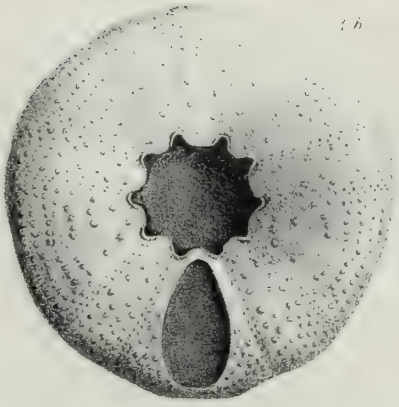
3 *a*. Holectypus oblongus, *Wright*, p. 267. Upper surface, natural size.

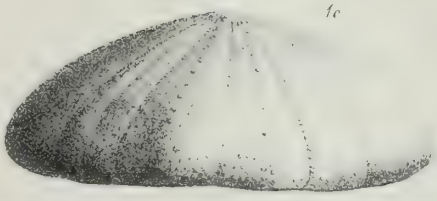
*b*. Base of a small specimen, natural size.

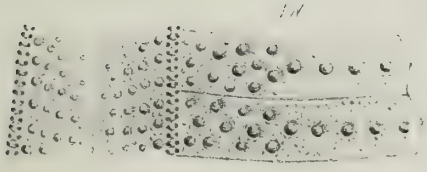
*c*. Lateral view of *a*, natural size.

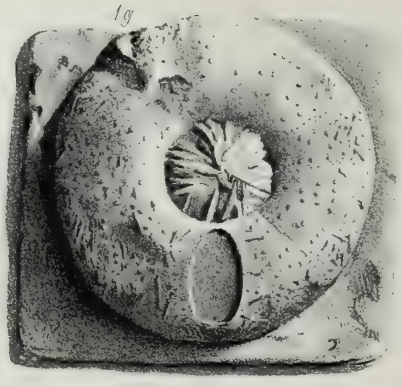
*d*. Ambulacral area, poriferous zones, and two inter-ambulacral plates, magnified four diameters.

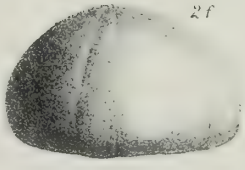


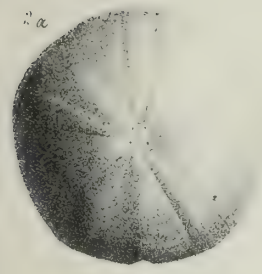


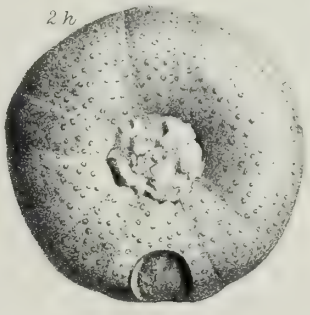


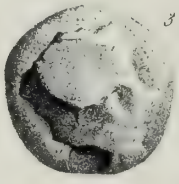


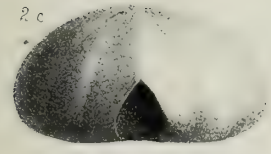



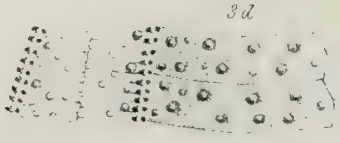



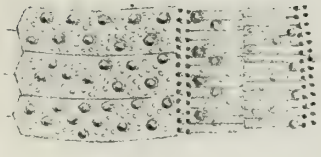



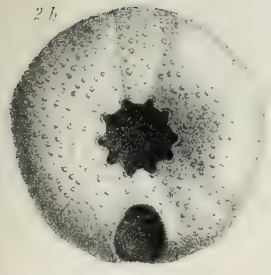


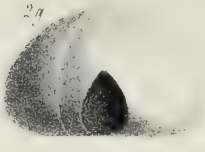



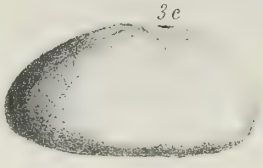


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# PLATE XIX.

*Pygasters from the Inferior Oolite.*

Fig.

1 *a*. PYGASTER SEMISULCATUS, *Phillips*, p. 275. Upper surface, natural size.

*b*. Under surface, natural size.

*c*. Lateral view of the same test.

*d*. Ambulacral area, poriferous zones, and two inter-ambulacral plates, magnified three diameters.

*e*. Primary tubercle, with the areolar circle of granules, magnified eight times.

*f*. Primary tubercle of the ambulacral area, magnified eight times.

*g*. Primary tubercle from the base, magnified eight times.

*h*. Primary tubercle from the ambulacral area, magnified eight times.

2 *a*. PYGASTER CONOIDEUS, *Wright*, p. 278. Upper surface, natural size.

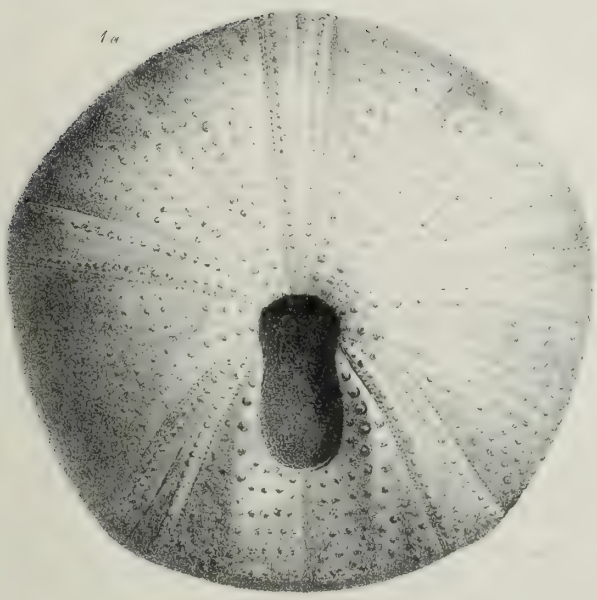
*b*. Under surface, natural size.

*c*. Lateral view, natural size.

*d*. Ambulacral area, poriferous zones, and two inter-ambulacral plates, magnified two diameters.

*e*. Primary tubercles from the upper surface, magnified eight times.

*f*. Primary tubercles from the base, magnified eight times.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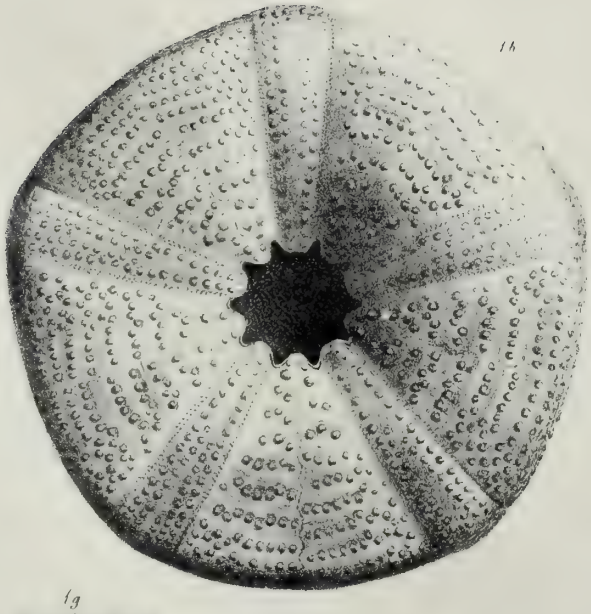
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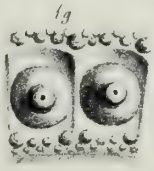
1g

1hh

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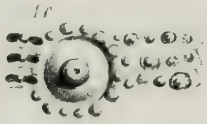
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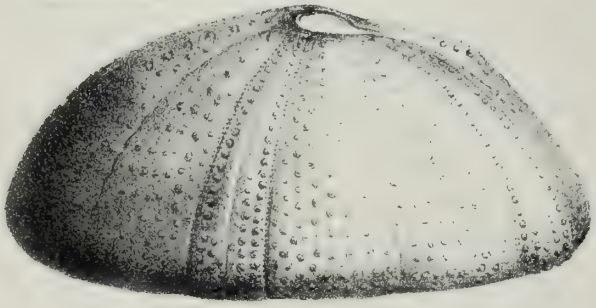
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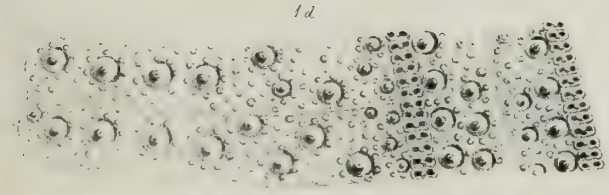
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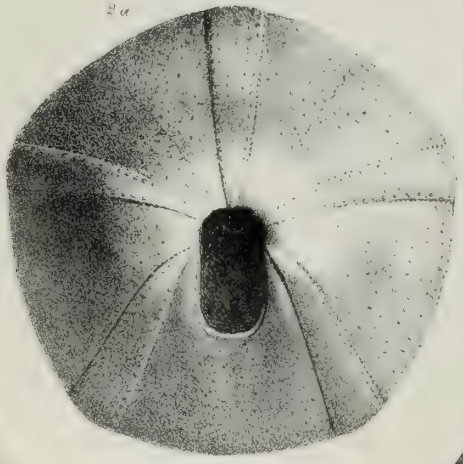
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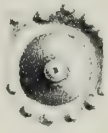
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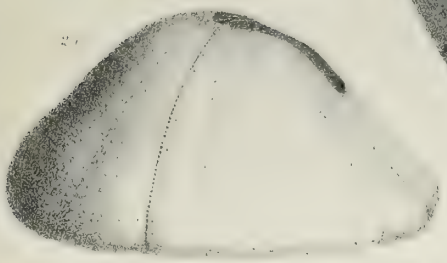
2c

2b

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## PLATE XX.

*Pygaster from the Cornbrash.*

Fig.

1 *a*. Pygaster Morrisii, *Wright*, p. 280. Upper surface, natural size.

*b*. Under surface, natural size.

*c*. Lateral view, natural size.

*d*. Ambulacral area, poriferous zones, and inter-ambulacral plates, magnified four diameters.

*e*. Primary tubercle from the upper surface, with areolar circle of granules, magnified eight times.

*f*. Primary tubercle from the base, magnified eight times.

*Pygaster from the Coral Rag.*

2 *a*. Pygaster umbrella, *Agassiz*, p. 282. Upper surface, natural size.

*b*. Under surface of another specimen, natural size.

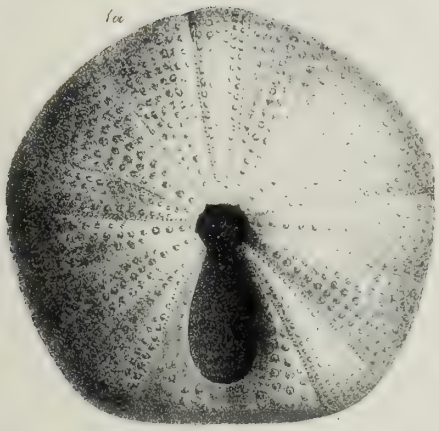
*c*. Lateral view of *a*.

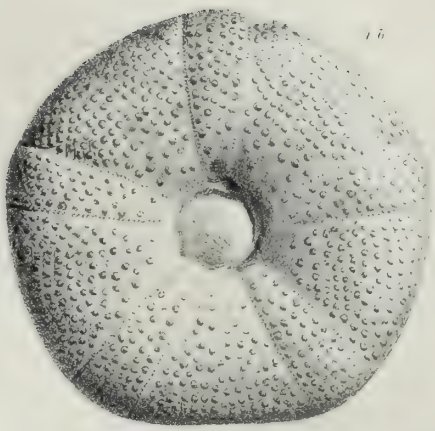
*d*. Ambulacral area, poriferous zones, and inter-ambulacral plates, magnified three diameters.

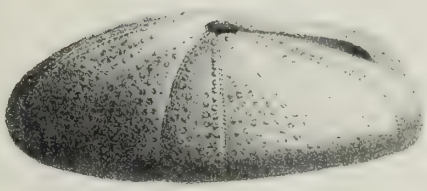
*e*. A portion of the apical disc, showing the four perforated ovarial plates and madreporiform body, magnified two and a half times.

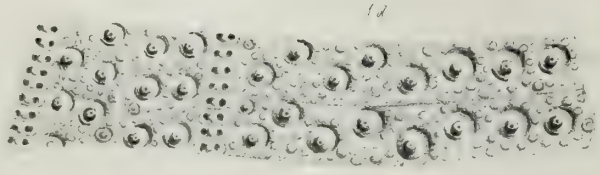
*f*. A primary tubercle, with its areolar circle of granules, magnified eight times.

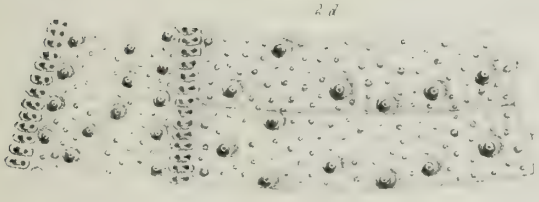
*g*. A primary tubercle from the base, magnified eight times.

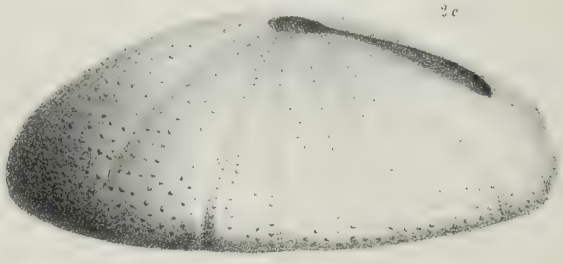


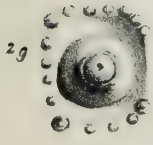


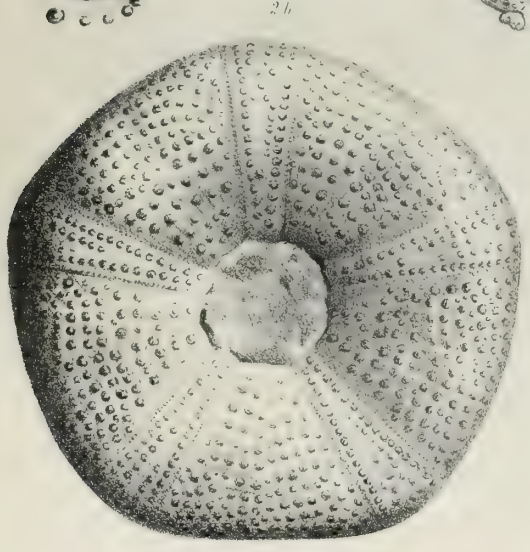



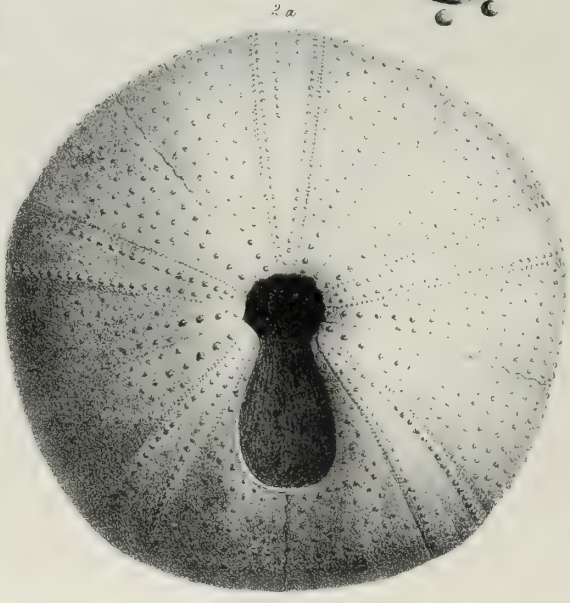



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## PLATE XXI.

*Hyboclypi from the Inferior Oolite.*

Fig.

1 *a*. Hyboclypus agariciformis, *Forbes*, p. 292. Upper surface, natural size.

*b*. Under surface of the same test.

*c*. Lateral view of the same.

*d*. Ambulacral area, poriferous zones, and two inter-ambulacral plates, magnified two and a half times.

*e*. Basal portion of an ambulacral area, showing the trigeminal pores near the peristome.

*f*. Primary tubercle from the upper surface.

*g*. Primary tubercle from the base, both highly magnified.

2 *a*. Hyboclypus gibberulus, *Agassiz*, p. 298. Upper surface, natural size.

*b*. Under surface of the same test.

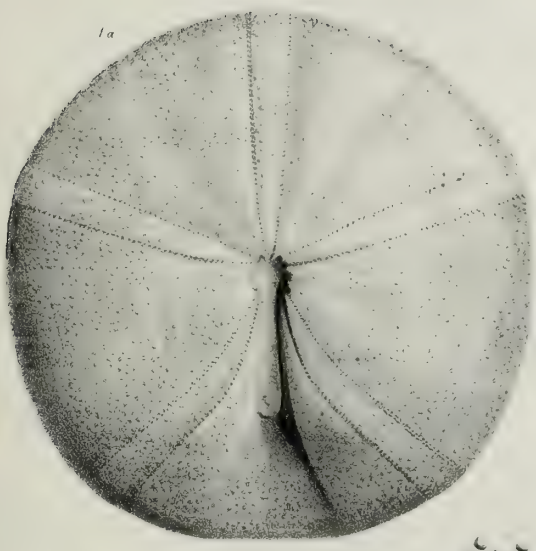
*c*. Lateral view of the same.

*d*. Front view, showing the elevation of the gibbous crest, and the depression of the single inter-ambulacrum.

*e*. The apical disc, magnified two and a half times.

*f*. Ambulacral area, poriferous zones, and two inter-ambulacral plates, magnified two and a half times.

*g*. Primary tubercle from the upper surface, surrounded by miliary granules, highly magnified.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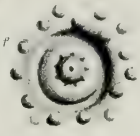
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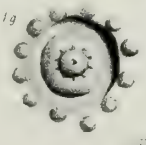
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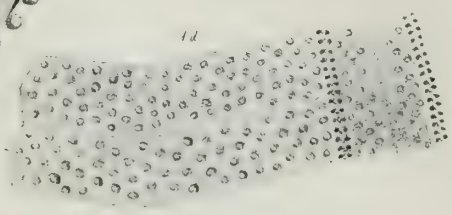
1c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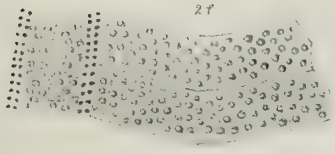
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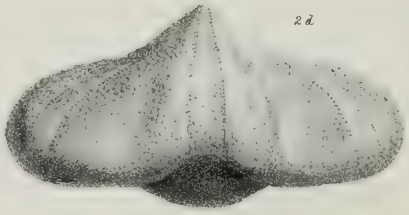
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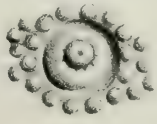
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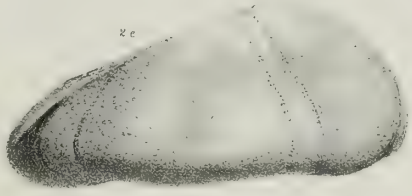
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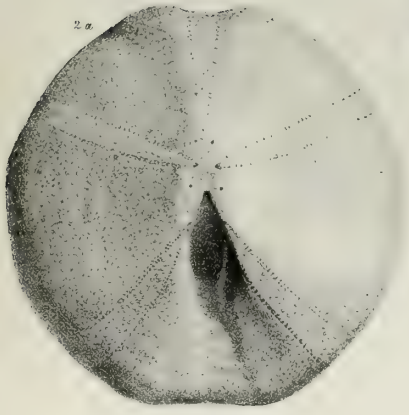
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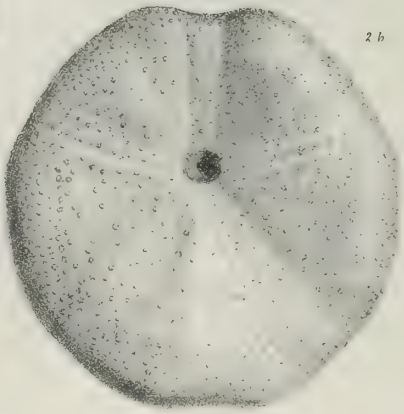
2b

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# PLATE XXII.

## *Hyboclypi from the Inferior Oolite.*

Fig.

1 *a*. Hyboclypus ovalis, *Wright*, p. 301. Upper surface, natural size.

*b*. Under surface of the same test.

*c*. Lateral view of the same.

*d*. Ambulacral area, poriferous zones, and two inter-ambulacral plates, magnified three diameters.

*e*. The apical disc, magnified three diameters.

*f*. Basal portion of an ambulacral area, showing the distance of the pores apart, in this region, from the size of the plates, magnified three times.

2 *a*. Hyboclypus caudatus, *Wright*, p. 296. Upper surface, natural size.

*b*. Under surface, natural size.

*c*. Lateral outline of the same.

*d*. Upper surface of the common form of this urchin, with the disc.

*e*. Base of the same test.

*f*. Lateral view of a broad variety.

*i*. Upper surface of the same test.

*k*. Outline of a conical variety.

*g*. Ambulacral area, poriferous zones, and inter-ambulacral plates, magnified three times.

*h*. The apical disc of *d*, magnified four diameters.

## *Collyrites from the Inferior Oolite.*

3 *a*. Collyrites ringens, *Agassiz*, p. 306. Upper surface, natural size.

*b*. Under surface of the same test.

*c*. Lateral view of the same.

*d*. Posterior view, showing the position of the vent, and the arch formed by the posterior pair of ambulacra.

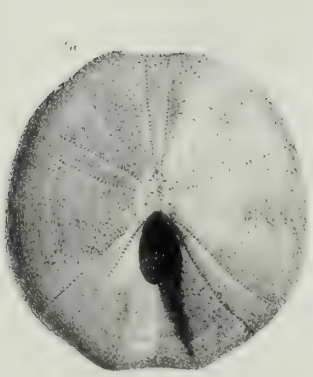
*e*. Ambulacral area, poriferous zones, and inter-ambulacral plates, magnified three times.

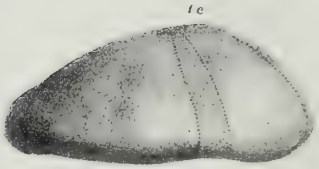
*f*. Ambulacral area, poriferous zones, and inter-ambulacral plates, magnified three times.

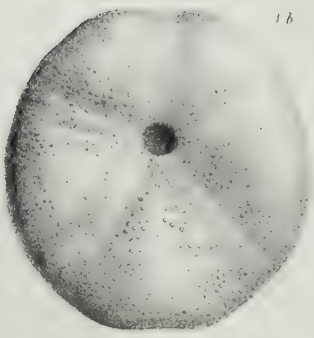
*g*. Primary tubercles, and miliary granules, highly magnified.

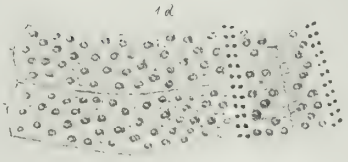
*h*. Oviductal holes, madreporiform body, and terminations of the three anterior ambulacra.

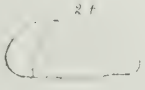
*i*. Diagram of the structure of the test; the plates of the disc, and those above the vent not made out.

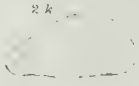


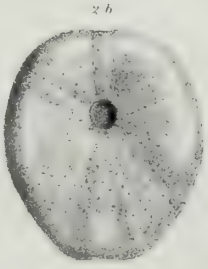



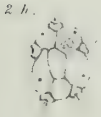



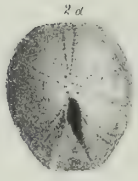



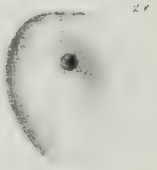


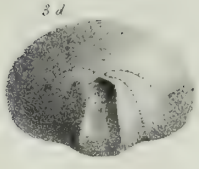



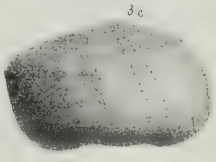


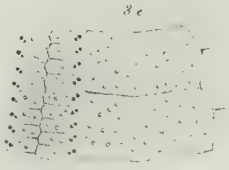



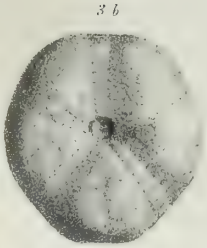







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THE

# PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCLVII.

# A MONOGRAPH

OF THE

# FOSSIL

# MALACOSTRACOUS CRUSTACEA

OF

# GREAT BRITAIN.

BY

PROFESSOR BELL, F.R.S., F.G.S., ETC.

PRESIDENT OF THE LINNEAN SOCIETY.

PART I.

CRUSTACEA OF THE LONDON CLAY.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1857.

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# INTRODUCTION.

In examining the zoological characters of the Crustacea which existed during the Eocene period, it is impossible not to be struck by the fact, that notwithstanding the obvious relation in most of them to the members of recent groups, amounting often to an almost typical representation of a family, there is at the same time, probably without exception, such a discrepancy as forbids their association under the same generic formula. In some few cases, indeed, it has been difficult, in consequence of that general destruction of the minute but very important organs about the oral, antennary, and ophthalmic regions, which too often prohibits any very correct appreciation of the relations of the species, to assign to the extinct form its true place amongst its recent allies. But ordinarily there have been, amongst the numerous specimens which I have been so fortunate as to have placed at my disposal, some which have sufficed to indicate their affinities with great probability, if not with absolute precision; and these have led me to adopt the conclusion above stated, which is somewhat at variance with the recognised relation between the Eocene and more recent forms of most other classes of animals, of which representatives are found even in that early member of the tertiary series.

In making the necessary comparisons, and in endeavouring to assign to the different characters and structures their absolute or relative importance, I have found it requisite to investigate with some care the homologies of the different regions and subordinate portions of the carapace, as it happens too often that we are driven to that part, almost exclusively, as the basis of our diagnosis. I will, therefore, make a few remarks on this important element in our generalization, before I enter upon the detailed application of these data to the determination and description of the objects themselves.

The first distinct attempt at an anatomical division of the carapace into "regions," on the basis of their presumed relation to the viscera which they respectively cover, was made by Professor Desmarest, in his portion of the 'Histoire Naturelle des Crustacés

Fossiles,' in which he was associated with Alex. Brongniart. It is unnecessary now to enter into any detailed correction of this system, which, although possessing great merit as containing the groundwork of a sound nomenclature and many valuable suggestions, is still in some respects erroneous and overladen with terms which are too circumscribed, and in some instances referred to organs with which they have no very obvious relation.

Professor Milne Edwards, in his great work, the 'Histoire Naturelle des Crustacés,' improved upon Desmarest's division of the carapace, but it still wanted that simplicity and generalization which are so important in all systems of nomenclature. Dana, whose knowledge of the subject and enlarged general views entitle his opinions to great respect, proposed a plan of the regions of the carapace, founded only on their position on the carapace and in relation to each other; but it appears to me that the memory is greatly aided and the true relation of the regions more nearly approached, by assigning to each its appropriate function, so to speak, as the protecting covering of the subjacent viscus. Still keeping this principle in view, Dr. Milne Edwards has, in a more recent work, his admirable treatise on the homologies of the organs of Crustacea, presented a less complicated nomenclature, which, with some modifications, I shall adopt in the descriptions of genera and species in the present work.

In following the classification of these parts, as given by this distinguished naturalist, I cannot, however, conceal from myself that there are some points on which, as it appears to me, he is in error. The hepatic region, for example, is one of the smallest of the whole, although the organ to which it nominally stands in relation is of enormous development in the whole of the sub-class with which we have to do, and the region to which the name is given is, by its position, related to only a very small fragment of it. The divisions of the branchial region may, I think, be improved by apportioning a much smaller area to what the author calls the meso-branchial lobe, a limit which is, in very many cases, indicated by a natural line of demarcation. This alteration I propose to adopt. I should have been disposed to change the names of these, and, perhaps, of some other subdivisions of the carapace, but from a disinclination to interfere with a nomenclature already established by so sound an authority, and thus to create confusion by the multiplication of synonyms in terminology.

This is not the place to discuss the theory of the homologies of the two primary divisions of the carapace. Much yet remains to be done in this intricate question, and it has recently undergone the investigation of a very competent observer, Mr. Huxley, who has taken the only sure basis for a satisfactory conclusion, that founded upon development. The division, however, into two distinct elements, limited theoretically, and, in many forms, actually, by a definite line of demarcation, is so entirely borne out by facts, that I shall assume it as proved, and found my descriptions upon that principle. This division is most obvious in the Macrura, and some of the Anomura; but it is by no means rare in the Brachyura, although in these the boundary furrow is less distinguished from the subordinate regional grooves. The sulcus by which it is indicated is termed

by M'Coy the nuchal furrow, and by Milne Edwards "le sillon cervical." It passes in a very uneven line behind the hepatic region, backwards by the side of the metagastric lobe and across behind the urogastric. Thus the anterior portion to which Professor Edwards gives the name of cephalic arch ("arceau cephalique") consists of the frontal, the orbital, the gastric, and hepatic regions; and the posterior portion, the scapular arch ("arceau scapulaire"), is formed of the branchial and cardiac.

I take the normal form of the Brachyurous carapace (to which for the present I confine my attention) to be that in which the regions and their secondary divisions or lobes are more or less distinctly marked by furrows, and the latero-anterior margin furnished with five processes, including the extra-orbital process, in the form of spines, teeth, or tubercles. This will be sufficient for my present purpose, and it would only be involving an unnecessary and ambiguous discussion to enter, in this place, into a more intricate subdivision of the regions.

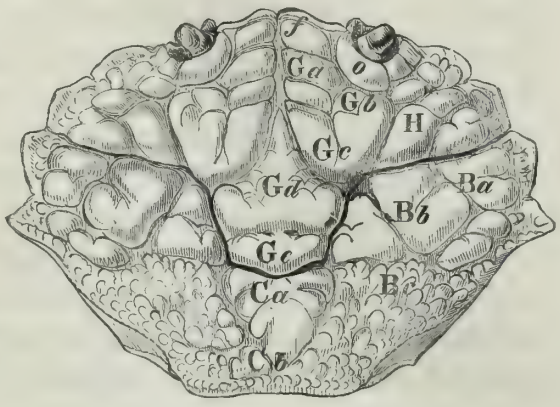
In the normal form of the Brachyurous carapace there are, according to the system which I here adopt, nine regions. Of these three are single, placed on the median line, and three pairs, which occupy the lateral portions of the carapace. The azygos regions are the frontal, the gastric, and the cardiac; the pairs are the orbital, the hepatic, and the branchial. The frontal region is placed at the anterior margin, and is generally very small in the typical Brachyura; but in the Oxyrynchi and in most of the Macrura and several of the Anomura, it is developed into a more or less projecting rostrum. It is circumscribed behind and above by the gastric, and laterally by the orbital regions, and beneath it ordinarily joins a projection of the epistome, and covers the antennules or internal antennæ, forming the upper vault of the antennary fossæ. The orbital region on each side is also small, and occupies the anterior margin of the carapace from the frontal to the hepatic regions, and it is bounded behind by the broad anterior margin of the gastric, from which it is generally distinguished by a slight elevation. It is often armed with a spine or tooth or tubercle on its inner and outer angle, the latter forming the first of the five normal projections of the latero-anterior margin of the carapace. The gastric region occupies, in most cases, a very extensive portion of the anterior half of the carapace, extending at its anterior margin along the whole breadth of the frontal and orbital regions; it is bounded laterally by the hepatic and branchial, and posteriorly by the anterior (epicardiac) lobe of the cardiac. It is divided into lobes which are more or less distinct and prominent, in some cases being almost as strongly distinguished from each other by grooves as the regions themselves, in others altogether confluent, and scarcely recognizable by slight elevations. The anterior pair (epigastric), which are in contact with the frontal, and in some cases extending to the orbital regions, are very small and ordinarily inconspicuous; the next which are termed protogastric are very large, and occupy the greater part of the area of the gastric region; the union of this pair of lobes is often interrupted by an elongated projection of the next lobe, the mesogastric, which is placed in the mesial line, and is identical with what was formerly called the genital

region; the metagastric lobes are placed behind those hitherto mentioned, and generally meet on the mesial line, behind the mesogastric, becoming confluent; the posterior lobe of this region is called the urogastric, and often consists of a mere narrow, transverse line, sometimes confounded with the anterior, although, in other cases, it is as long as it is broad, and quite readily distinguished. The hepatic region is somewhat triangular, and occupies externally the anterior part of the latero-anterior margin, from the orbital to the branchial; it is bounded on its inner side by the protogastric lobes, and behind by the epibranchial; in those cases in which the margin is furnished with the normal number (five) of processes, the hepatic region has the second and third allotted to it. This region is, in many instances, confluent with the gastric and branchial, but in others the limiting furrow is sharp and distinct, and constitutes a portion of the *sulcus cervicalis*, which divides the cephalic from the scapular arch, as before described. The cardiac is the posterior mesial region, and answers to the cardiac and intestinal regions of Professor Milne Edwards's former arrangement, and to the "cordiale" and "hepatique postérieure" of Desmarest. It is bounded anteriorly by the urogastric lobe, laterally by the metabranchial, and posteriorly forms the posterior margin of the carapace. It is composed of two portions, named by M. Edwards the anterior and posterior lobes, but for which I propose the names respectively of epi- and meta-cardiac. The branchial regions are very large, occupying in most cases the moiety of the area of the carapace; and in some, particularly of the triangular forms, even much more. Externally, it forms the posterior half of the latero-anterior and the whole of the latero-posterior margin of the carapace. Its anterior boundary is the hepato-branchial portion of the cervical furrow, and the inner the gastro-branchial and cardi-branchial furrow. It is divided into three tolerably distinct parts, termed the epi-, the meso-, and the meta-branchial lobes. The first of these extends across the lateral portion of the carapace from the lateral margin, the fourth process of which, when it exists, essentially appertains to it; the inner margin usually coincides with the meta- and uro-gastric lobes. The meso-branchial lobe I propose to limit to a much smaller area than has been assigned to it; an area which is in many genera so clearly defined as to involve, I think, no ambiguity. It is commonly a triangular or rhomboidal space, embracing the fifth marginal tooth, and extending but a short space inwards between the epi- and meta-branchial lobes. The latter is a broad space, forming nearly half of the whole branchial region, and it frequently presents a surface of so different a character from the rest of the carapace as to be readily distinguishable. This will be found very strongly marked in the genus *Dromilites*, and particularly in that species to which Desmarest gave the name of *Inachus Lamarckii*.*

Such appear to me to be the essential divisions of the carapace in the Brachyurous

* So striking is their structure in the species in question, that Mr. M'Coy considered it as the principal character on which he founded his genus *Basinotopus* (now referred to *Dromilites*), which also suggested the name. He, however, appears to have failed to ascertain its true character as the modified meta-branchial lobe.

and Anomurous Crustacea, distinguished so far as is necessary for my present purpose. Their modifications in the Macrura will be readily understood by reference to the different forms of that group. The example I have here selected for the illustration of this structure is *Zozymus æneus*,* which, although exhibiting many still subordinate divisions or lobules, which need not here be designated, demonstrates with remarkable clearness those points which I have thought it requisite to describe, and is, perhaps, as nearly normal as any one I could have chosen. It is scarcely necessary to state that the foregoing descriptions are to be considered as belonging to the normal form, and that there are to be found in be different species, variations of every part to the greatest imaginable extent, always, however, preserving their mutual relations.




When it is considered how numerous are the Crustacean fossils which exist in the London Clay, and how plentifully many of the species are distributed, and the interest which attaches to this class of animals, both on account of their general structure and particularly of the relation in which they stand to the different formations in which they are found, it is remarkable that so little attention has hitherto been paid to them, and that so few species have ever been described. The crustacean inhabitants of the earliest seas, indeed, have not been subject to this neglect, for the Trilobites have long since been thoroughly studied, and have been made the subject of much philosophical research and of many elaborate publications. The Chalk Crustacea of Great Britain have also received a fair share of attention; but those of the Eocene period have been almost wholly neglected. In Professor Morris's 'Catalogue,' published in 1843, there are only three species of Malacostracous Crustacea recorded as belonging to this formation, and for the announcement and description of two of these we are indebted to a French naturalist. Since that period there has been scarcely a record of an additional species, until a paper by Professor M'Coy appeared in the 'Annals of Natural History,' in the year 1849,† in which five additional species are described from the London Clay, preserved in the Woodwardian Museum at Cambridge, and other collections.

* In the figure, the following letters indicate the regions and principal lobes: *f*, the frontal region; *o*, the orbital; H, the hepatic; G, the gastric region; G*a*, the epigastric lobe; G*b*, the protogastric; G*c*, the mesogastric; G*d*, the metagastric; G*e*, the urogastric. B, the branchial region; B*a*, the epibranchial lobe; B*b*, the mesogastric; B*c*, the metagastric. C, the cardiac region; C*a*, the epigastric lobe; C*b*, the metagastric.

† On the Classification of some British Fossil Crustacea, with notices of some new forms in the University collection at Cambridge, 'Ann. Nat. Hist.' 1849, pp. 181, 330, 392.

It will probably be thought by many that in the descriptions of the species, and, perhaps also, in the generic diagnostic phrases, I have entered into needless minutiæ of detail; and that it would have been as well if I had limited myself to those characters which are found sufficient in the descriptions of recent forms. But when it is recollected that most of the specimens occur in a more or less fragmentary condition, and that it often happens that a small portion only of an individual is preserved, it will be obvious that unless the description includes every part which remains (and this is often too little for accurate or certain determination), there would be no means of ascertaining the identity of newly-found specimens with the type of the previous description. I have, therefore, notwithstanding this apparent tediousness, given the fullest detail in my power of the different parts which still remain, so that, as far as possible, there may be some grounds for future satisfactory comparison. In the description of recent forms this minuteness of detail is obviously unnecessary, as it may be fairly expected that the object to be compared will be nearly or quite perfect and unmutilated. With all possible care, however, it must still often happen that characters of great importance both in distinguishing species, and (which is of even more frequent occurrence, and more important with reference to the higher views of zoological science), in ascertaining the relations of genera, are absolutely wanting, or so defective as to be scarcely available.

Amongst the remains of an earlier period which are found in the Suffolk Crag, are several species of the Crustacea peculiar to the London Clay, and I may particularize two species of *Xanthopsis*, *Xantholites Bowerbankii*, *Dromilites Lamarckii*, and two species of Macrura; all the specimens which have come under my observation have been much rolled and worn.

It is unnecessary to urge upon those who are accustomed to the study of Crustacea, the necessity of great caution lest the same species at different ages should be described as distinct; and if this be the case with respect to these animals in the perfect condition in which the recent species are obtained, and where all the organs are consequently submitted to examination, it is far more so when fragments only are obtainable, or, at best, where many of the organs most important in the discrimination of species are lost. Hence, we may presume, has arisen the mistake which has become public by the printed statement of Professor Morris, in the preface to his admirable 'Catalogue,' that in the collection of Mr. Bowerbank alone, there are not less than thirty species of Crustacea from the London Clay. I have most carefully examined that admirable collection, the equally numerous one of Mr. Wetherell, that of the British Museum, of the College of Surgeons, and of the Woodwardian Museum at Cambridge; and these, with the addition of my own and one or two other small collections, have afforded in the whole, not more than nineteen species. Of these ten belong to the Brachyura, three to the Anomura, and six to the Macrura.

Of these species, the greater number of the Brachyura are found in the greatest

abundance in the first or Sheppey zone of Mr. Prestwich. This is the case even with those species which are common to most of the districts of the London Clay, particularly the two most common species of *Xanthopsis*. The genera *Mithracia*, *Xanthilites*, *Plagiolophus*, *Portunites*, *Œdisoma*, *Campylostoma*, and *Goniochele*, and the Macrurous genus *Scyllaridia* are, as far as I have observed, confined to this zone. There is one species, *Cyclocoryster pulchellus*, which has hitherto occurred only in the third zone, a single specimen having been found at Holloway. *Hoploparia gammaroides* is far more numerous at Sheppey than in either of the other localities, but it also occurs in the Highgate and Holloway districts. *Hoploparia Bellii*, on the contrary, is far more numerous in the North London than in the Sheppey zone, and appears to be equally common to both the second and third zones of Mr. Prestwich. Finally, *Archæocarabus Bowerbankii* is principally, but not exclusively, a Sheppey species; a few specimens from Holloway existing in Mr. Wetherell's collection. I subjoin a list of the species described in the present work, with the localities in which they occur.

| Species. | Sheppey, Herne Bay, and Southend. | Highgate. | Whetstone, Holloway, Hornsey, &c. | Alum Bay. | Bognor. |
|---|---|---|---|---|---|
| Mithracia libinioides | — | | | | |
| Xanthopsis Leachii | — | — | — | — | — |
| bispinosa | — | — | — | | |
| unispinosa | — | — | | | |
| Xanthilites Bowerbankii | — | | | | |
| Plagiolophus Wetherellii | — | | | | |
| Portunites incerta | — | | | | |
| Œdisoma ambiguum | — | | | | |
| Campylostoma matutiforme | — | | | | |
| Cyclocorystes pulchellus | | | — | | |
| Goniochele angulata | — | | | | |
| Dromilites Lamarckii | — | — | ? | | |
| Bucklandii | — | — | | | |
| Hoploparia gammaroides | — | — | — | | |
| Bellii | — | — | — | | — |
| Trachysoma scabrum | | — | | | |
| Thenops scyllariformis | — | — | — | | |
| Scyllaridia Koenigii | — | | | | |
| Archæocarabus Bowerbankii | — | ? | — | | |

The other districts in which the London Clay exists have not been hitherto examined with any degree of care and diligence; and it is probable that there are yet several species which have not been discovered, and which will reward the researches of some future investigator.

There are, in the Hunterian Collection of the Royal College of Surgeons, a considerable number of fossil Crustacea from the London Clay, belonging to the following species: *Xanthopsis Leachii*, *X. bispinosa* (?), *Xanthilites Bowerbankii*, *Goniochele angulata*, *Dromilites Lamarckii*, *Thenops Scyllariformis*, *Hoploparia Gammaroides*, *H. Bellii*, *Archæocarabus Bowerbankii*. These are all from Sheppey, and constitute part of a collection of fossils formed principally by Hunter himself, and now in the course of arrangement in the museum under the care of Professor Morris. It is very interesting to find that, amongst the immense riches belonging to the recent creation, collected by our greatest comparative anatomist and physiologist, there are so many examples of the "organic remains of a former world," most of which have since been, as it were, re-discovered and described, without the least suspicion that even these ancient beings had not escaped the grasp of that universal mind.

To those gentlemen who have with the most unrestricted liberality and kindness placed their treasures at my service, and especially to Mr. Bowerbank and Mr. Wetherell, whose unrivalled collections have formed the basis of this work, my thanks are cordially rendered. To Professor Sedgwick and Mr. Barrett, of Cambridge, to Mr. Woodward, of the British Museum, to Professor Morris, to Mr. Prestwich, and other friends, I am also greatly indebted; and the imperfections of this monograph can urge no claim to indulgence from the want of the kindest sympathy and assistance from those who had the opportunity of rendering it.

# MONOGRAPH

OF THE

# FOSSIL MALACOSTRACOUS CRUSTACEA

OF

# GREAT BRITAIN.

## PART I.—Of those found in the London Clay.

### Order—*BRACHYURA.*

### Sub-Order—OXYRHYNCHI.

### *Family*—MAIADÆ.

### *Genus*—Mithracia, *Bell.*

*Char. Gen.* *Testa* subglobosa, tumida, rostro integro, supra sulcato. *Orbitæ* ovatæ, supra bifissæ. *Antennæ* ad basin rostri insertæ. *Pedipalpi externi* caule interiore sulco longitudinali diviso, caule exteriore lineari. *Abdomen* maris ——? fœminæ ovatum, segmentis omnibus separatis.

Species unica. Mithracia libinioides, *mihi.* Plate V, figs. 10—12.

*Descr.* Carapace tumid, nearly globular, as broad across the branchial region as it is long, exclusive of the rostrum, covered uniformly with small tubercles; regions elevated, distinct, the separating furrows narrow and smooth; rostrum moderately projecting, entire, with a small sulcus or depression above; gastric region with distinct lobes; the two protogastric meeting at the median line and confluent; the mesogastric triangular, and separated by a distinct furrow from the two metagastric, which are rather distinctly marked; the urogastric twice as broad as it is long; cardiac region gibbous in the centre; hepatic region rounded, raised and projecting at the margin; the branchial very large, rounded, and tumid; orbits oval, slightly divided at the bottom into two portions by a small, transverse line; antennæ inserted beneath the base of the rostrum; external footjaws with the inner stalk

longitudinally divided by a furrow, outer stalk linear; female abdomen oval, the sixth segment as long as the fourth and fifth together, the seventh triangular.

Length and breadth of the carapace 0·9 inch.

*Obs.* The above description is taken from several specimens in Mr. Bowerbank's collection, and in the British Museum. In none of them are there any remains of the limbs. In one only, a female, is the abdomen existing, and in another the body is sufficiently perfect to give the form of the rostrum, and the above imperfect details of the antennæ, orbits and external footjaws. These data are sufficient to indicate a marked affinity to several genera of the family Maiadæ, to which the fossil evidently belongs; and whilst in some respects the structure appears to point to a near relation to *Mithrax*, in others it appears to approximate to *Libinia*.

This is the only instance known of any fossil representative of the extensive tribe of the Oxyrhynchi; and this circumstance renders it one of the most interesting additions we have made to our knowledge of extinct Crustacea. Professor Milne Edwards has the following observation on this subject.* "Jusqu' ici nous ne connaissons aucun Crustacé fossile que l'on puisse regarder, avec quelque certitude, comme appartenant à la famille des Oxyrhinques." The species referred by Desmarest to the genus *Inachus*, is, as will be shown, a species of the Anomurous group, and is nearly allied to *Dromia*. It will be found described under the name of *Dromilites Lamarckii*, and is the *Basinotopus* of M'Coy. It has no relation whatever to the present family, and thus, until the present instance, the observation of Edwards remained unexceptional.†

All the specimens known are from the Isle of Sheppey.

## Sub-Order—CYCLOMETOPA.

### *Family*—CANCERIDÆ.

#### *Genus*—Xanthopsis, *M'Coy.*

*Char. Gen. Testa* ovata, supra nodosa, fronte quadrilobo. *Orbitæ* latæ, angulis lateralibus et inferiore prominentibus. *Fossæ antennariæ* ovatæ, apertæ. *Antennæ externæ* articulo basali bis longiore quam latiore, lateribus parallelis: *internæ* articulo basali laté triangulari, anticé truncato, ad frontem attingente. *Pedipalpi externi* caule

* 'Hist. Nat. des Crust.,' tome i, p. 271.

† Since the above was written, Mr. Woodward has pointed out to me in the British Museum a small specimen (a Crustacean) from the Gault, which appears to belong to the Oxyrhynchi, and which would constitute a second exception. I have also been favoured with two specimens from the collection of M. Edwards, one from Colwell Bay, in the Isle of Wight, the other from Brockenhurst, Hants, which may possibly prove to belong to the Oxyrhynchi, but which require further examination. These will be further considered at a future time.

exteriore antrorsúm sensim angustiore, caulis interioris articulo secundo quadrato, articulo tertio ad angulum antico-interiorem truncato. *Pedes antici* inequales, robusti, manu margine superiore tuberculato-cristatâ: *reliqui* graciles, simplicissimi, subcylindrici. *Abdomen* MARIS articulis a tertio ad quintum coalitis; FŒMINÆ omnibus disjunctis.

The carapace, in all the species of this genus, is more or less convex, particularly from the front backwards, and considerably so from side to side, and in every part almost uniformly and deeply punctate. The nodules or elevations on the carapace vary in height in the different species, but they occupy the same situations in all. There is one of a depressed form on each protogastric lobe, one on the mesogastric, one more raised on the metagastric, two on the cardiac region, and four on the branchial—namely, two on the epibranchial lobe, and two on the metabranchial; the one towards the centre being elongate, and often appearing like two united. The latero-anterior margin has indications of the normal number of processes, namely, five, but they vary greatly in their development in the different species. The front has four distinct and strongly marked obtuse teeth, including that on each side formed by the inner angle of the orbit. The outer angle also forms a rounded projection, constituting the first latero-anterior process, and the inferior a more acute one. The orbits are nearly round, and without fissures. The hiatus is entirely filled by the basal joint of the external antennæ, which is quadrate, about twice as long as it is broad, and extends forwards to the front, with which it is in contact. The second joint is somewhat pyriform, and lies within the orbit. The antennary fossæ are large and open, broadly oval, and, to the extent of two thirds, filled by the basal joint of the internal antennæ, which is broadly triangular, the outer margin being in contact with the external antenna throughout its length, the anterior angle touching the front, and the posterior margin supported by the anterior margin of the epistome. The epistome is three times as long as it is broad, the central projection touching the under surface of the front, and the lateral portions extending on each side to the base of the external antennæ. The pterygostomian processes are deep, and very slightly hollowed; the anterior margin of the sternum forms an obtuse angle, and is mucronate. The abdomen in the male very much resembles that in the genus *Xantho*. The first and second joints very broad and short; the third, fourth, and fifth united, with a slight groove between each, indicating the line of union; it is the broadest at the part answering to the third segment, and gradually narrows to the anterior part of the fifth; the sixth is of the same breadth, quadrate, a little broader than it is long; the seventh forms an equilateral triangle. The abdomen in the female is broadly oval; the segments increase regularly both in length and breadth from the first, which is very small and linear, to the fifth; the sixth much longer than the former, and rather more than twice as broad as it is long; the seventh is broadly triangular, the posterior angles being obliquely truncate in some individuals. The anterior legs are very large and robust: they are unequal, the right being ordinarily the larger: the first four joints are smooth;

the hand with a tuberculated crest on the upper margin, and with three, four, or five tubercles on the outer side; the fingers are furnished with a few strong tubercular teeth. The ambulatory legs are all smooth, rounded, slightly compressed, and without any armature or projections of any kind.

Such are the characters which exist in all the species at present known of this genus; and the characters of the species consist rather of variations in degree than in any marked and distinct deviation from the normal form.

The genus *Xanthopsis*, especially *X. Leachii*, is found in larger numbers than any other Crustacean in the London Clay. It was founded by Professor M'Coy* upon the well-known *Cancer Leachii* of Desmarest. The latter distinguished naturalist had received specimens, as he informs us, from Dr. Leach, to whom he dedicates the species known to him, and which was most probably *X. nodosa* of M'Coy. Desmarest considered it as belonging to the genus *Xantho* of Leach, which he evidently looked upon as only sub-generically distinguished from *Cancer*, which latter name he consequently applied to it.

Professor Milne Edwards† places it amongst those fossil species which appear to belong to his genus *Cancer;* but this mistake arose, doubtless, from the want of access to more perfect specimens. The following observations of Professor M'Coy‡ show the view which that gentleman took of its affinities. "It is nearer to Zantho by its tuberculated carapace, few tubercles on its latero-anterior margins, and position of the external antennæ at the inner canthi of the eyes, instead of between these and the front; but it differs in the great convexity of the carapace, and materially from both those genera in *both* sexes having seven separate joints in the tail, showing in this a closer relationship to *Pilumnus*, from which, however, the strong nodulation of the hind part of the carapace, and its oval, vaulted form, as well as the quadrilobed front and great extent of the gastric region, distinguish it." The ground upon which this supposed relation to *Pilumnus* rests, even were it correct, would be of little comparative value. The number of united segments of the abdomen varies considerably even in the different species of certain genera. In some, as in *Leucosia*, for instance, a perfectly natural and circumscribed genus, some species have the whole of the joints of the abdomen united; others the third with the fourth, and the fifth with the sixth; but it is very remarkable that Professor M'Coy is entirely mistaken as to the structure of the male abdomen in *Xanthopsis*. It is absolutely identical with that in *Xantho*. The third, fourth, and fifth segments are as completely united in the former as in the latter form. In examining a considerable number of specimens in which the abdomen is perfect, I found them all in the condition I have just mentioned. There is, in all cases, a slight transverse groove indicating the

* 'Annals of Nat. Hist.,' 1849, p. 162.

† 'Hist. nat. des Crust.,' vol. i, p. 380.

‡ Loc. cit., p. 163.

junction, but in no case is there any separation between the segments in question, whilst the first from the second, the second from the third, the fifth from the sixth, and the sixth from the seventh, are, in every instance, unmistakeably disjoined. The only possible relation of *Xanthopsis* to *Pilumnus* is thus removed, and its affinity to *Xantho* strengthened.

There is, however, another affinity, and that, as it appears to me, a very near one, which has not been alluded to by any former writer. I mean that indicated by many points of its structure to the genus *Carpilius*. In the general form of the carapace, and particularly the extraordinary curve from the front to the back, as well as a considerable arch from side to side, it differs essentially and strikingly from *Xantho*, and perfectly resembles *Carpilius*. The incurved and quadrifid front, which is found in every species of both genera, is no less obvious; and in the arrangement and form of the external and internal antennæ, the orbits, and the external footjaws, the structure approximates much more nearly the corresponding organs in *Carpilius* than in *Xantho* or any other existing genus; and in the simple rounded form of the ambulatory legs it possesses the only important character which distinguishes *Carpilius* from *Platypodia* (*Cancer* of M. Edwards). In fact, with the exception of the remarkable nodosities upon the different regions of the carapace, the existence of four more or less obvious tubercles on the latero-anterior margin, and the slight difference in the male abdomen—which in *Carpilius* has only the fourth and fifth segments united, whilst in *Xanthopsis* the third is also united to these—there are scarcely any striking characters separating the two genera. It is thus extremely probable that in any complete natural arrangement of the *Cancerida*, the genus *Xanthopsis* would occupy an intermediate and osculant position between *Xantho* and *Carpilius*.

The principal sources of my information on this genus, as in all the Crustacea of the London Clay, have been the British Museum, the splendid collections of Mr. Bowerbank and Mr. Wetherell, with a considerable number in the collection of Mr. Prestwich, and in my own. I have also had the opportunity of examining the specimens in the Cambridge Museum, which contains the identical specimens described by Professor M'Coy. These altogether amount, probably, to two or three hundred of the present genus. They of course vary greatly in their condition, and in the preservation of the different organs; but the whole have enabled me to ascertain and describe with great certainty and exactitude most of the minuter parts of structure on which the generic character mainly depends, and which are essential to the true understanding of the affinities. Thus the orbits, the eyes, the whole antennal region, with the basal portion of the external and internal antennæ, and at least two joints of the filament of the former, the external footjaws, the carapace with its regional prominences, the margin with its tubercles or spines, the abdomen of each sex, the entire chelæ and several joints of the ambulatory feet, have all been before me in a sufficiently perfect condition to enable me to ascertain their structure, and to restore, as it were, to its original

form, two at least of the species of the genus; the number and variety of the specimens fully making up for their individual fragmentary condition. I may state that it was by carefully clearing a beautiful specimen of Mr. Wetherell's and one in my own collection, that I have been able to demonstrate the minute and rarely preserved parts about the antennal, the orbital, and oral regions, of which I have given a diagram.*

XANTHOPSIS LEACHII, sp., *Desmarest.* Plate I, figs. 1—4.

Testâ valdé convexâ, tuberculis magnis, prominentibus, margine antico-laterali tuberculis tribus obtusis; fronte incurvo.

CANCER LEACHII, *Desmarest.* Crust. foss., p. 95, t. viii, figs. 5, 6.
XANTHOPSIS NODOSA, *M'Coy.* Ann. Nat. Hist., 1849, p. 163.

*Descr.* Carapace not more than from one sixth to one fifth wider than it is long; much elevated in the middle, so that its height, from a line drawn horizontally from the posterior margin to the front, is not less than three sevenths of its length; it slopes gradually to the sides, more considerably to the posterior margin, and almost abruptly to the front, which becomes nearly vertical; frontal lobes rounded and thick; latero-anterior margin with three obtuse rounded tubercles, diminishing in size and prominence forwards, the posterior one being on a line with the urogastric lobes; tubercles of the carapace large and rounded; the metagastric tubercle often longitudinally divided by a very shallow depression; those of the branchial region prominent, the posterior one extending forwards in a low, rounded ridge: the puncta on the surface considerably smaller than in *X. bispinosa*, particularly towards the anterior portion, where they are extremely small and shallow; the interspaces between the puncta studded with extremely minute granulations, which, in particular lights, are easily detected with a lens: chelæ of the male somewhat larger than those of the female, the right being ordinarily the larger; the superior margin forming a ridge which on the larger hand has ordinarily seven, and on the smaller four tubercles: there are also three distinct elongated tubercles not far from the junction with the wrist, one near the base of the immoveable finger, and a slight elevation near the moveable one. The fingers each furnished with about two strong tubercular teeth; abdomen of the male hastate, as given in the description of the genus; that of the female, broad oval.

*Obs.* This may with great propriety be considered as the type of *Xanthopsis*, as all the characters by which the genus is distinguished are developed in it, to the greatest degree.

* Plate I, fig. 7.

Such are particularly the convexity of the carapace, its tuberosities, the curvature of the front, and the development of the processes of the latero-anterior margin. The general minutely granulated surface of the interspaces between the puncta is peculiar to it, as, in the others, it only exists in an almost imperceptible degree, and that only in the neighbourhood of the marginal tubercles. The remarkable difference in the convexity of the carapace will be found detailed in the account of the next species, *X. bispinosa*.

I have thought it proper to restore the name of "*Leachii*" to this species, as I think there can be little doubt that this was the type to which Desmarest applied the term; and it is but fair, both to the giver and the object of the honour, not to change it unnecessarily. It is, however, with great reluctance that I venture to alter anything which has the sanction of Professor M'Coy's authority in this department of natural history, to which he has given a stimulus, and on which he has afforded us so much valuable information.

Numerous specimens of this species exist in the British and Cambridge Museums, in the collections of Mr. Bowerbank, Mr. Wetherell, Mr. Prestwich, in my own, and in every collection of London Clay fossils, derived from various localities—from the northern suburbs of London, from the Isle of Sheppey, and the opposite shore of Essex, and one, somewhat different from the normal form, from Alum Bay in the Isle of Wight, and which is figured in Plate I, fig. 10.

XANTHOPSIS BISPINOSA, *M'Coy*. Plate I, figs. 5, 6.

Testâ modicé convexâ, tuberculis depressis; fronte feré horizontali; margine antico-laterali spinis duobus depressis, posteriore majore.

XANTHOPSIS BISPINOSA, *M'Coy*. Ann. Nat. Hist., 1849, p. 164.

*Descr.* Carapace nearly one third broader than long, transversely oval, moderately convex, sloping gently to the sides, more decidedly to the posterior margin than to the front, which is moderately inclined; the frontal lobes rather flattened; latero-anterior margin having only the posterior two tubercles, which are modified into depressed subacute spines, of which the hinder one is the longer, and is slightly recurved; the place of the anterior tubercle marked by a slight projection, which, however, varies in degree in different individuals. I have one in my collection in which it is so conspicuous as to have led me at first to consider it as specifically distinct. Tubercles of the carapace much less prominent than in *X. Leachii*, the puncta of the surface rather large, nearly as much so on the anterior portion as on the rest, and not obsolete in the grooves between the tubercles; chelæ as in *X. Leachii;* the tubercles of the crest of the hand being, however, less prominent, and one or two of those towards the finger nearly obsolete; abdomen

in both sexes as in the former species, excepting that in the female the sixth and seventh segments are larger in proportion.

Length of carapace, 1·8 inch; breadth, 2·5 inch; Height, 0·6 inch; thickness of the animal, 1·1 inch.

*Obs.* The distinctions between this and the former species consist rather in the proportion of the various parts, than in any strongly marked exclusive characters. It is wider and flatter in proportion; the height, taken from a horizontal line extending from the posterior margin to the front, being only one third of the length, whilst in *X. Leachii* it is nearly half. The whole of the tubercles are much less prominent, the carapace less convex—the front being nearly horizontal; the puncta of the carapace are larger, and almost as conspicuous towards the front and in the grooves between the tubercles as in the other parts, and there are scarcely any perceptible granulations on the interspaces between them. The difference in the number of tubercles on the crest of the hand, referred to by Professor M'Coy, is more apparent than real, arising only from the union of the two anterior ones. The tubercles on the outer face of the hand are exactly similar to those of *X. Leachii*.

It is found with the former species in the Island of Sheppey, at Southend, and in the northern suburbs of London, from which localities there are several specimens in the collections of Mr. Bowerbank, Mr. Wetherell, in my own, in that of the University of Cambridge, and in the British Museum.

### Xanthopsis unispinosa, *M'Coy*. Plate II, fig. 1.

Testâ, sextâ parte tantum latiore quam longiore, æqué convexâ, tuberculis regionum fere obsoletis.

Xanthopsis unispinosa, *M'Coy*. Ann. Nat. Hist., 1849, p. 164.

*Descr.* The carapace in this species is not more than one sixth broader than it is long; almost uniformly convex from front to back, and not much less so from side to side; the puncta on the surface more distant than in *X. Leachii*; the tubercles of the different regions very depressed or almost obsolete, though occupying the same places as in the other species; the posterior lateral process short, flattened, triangular, and sharp pointed; the penultimate one smaller, and the two anterior obsolete.

It is distinguished from *X. Leachii* by the less degree of deflexion of the front, by the very slight elevation of the tubercles on the posterior region, by the character of the lateral processes, and the more coarse punctation of the surface; and from *X. bispinosa* by the relative proportions of the length and breadth of the carapace, and by its more considerable and regular convexity.

After careful consideration, and the examination of several specimens, I have come

to the conclusion that this is a distinct species. Its name, *unispinosa*, is, however, a very incorrect one, for although the hindermost of the lateral processes is considerably larger than the one before it, this is not more the case than in many specimens of *X. bispinosa*. It has been obtained at Sheppey, and I believe also at Highgate, and exists in the British Museum, in the collections of the University of Cambridge, of Mr. Bowerbank, of Mr. Wetherell, of Mr. H. Gould, and of Mr. Searles Wood.

Length of carapace, 1·7 inch; breadth, 2 inches.

A somewhat mutilated specimen in Mr. Bowerbank's collection is considerably larger, but of similar proportions.

In Mr. Bowerbank's collection there is a specimen of a *Xanthopsis* which resembles in its general form *X. Leachii;* its proportions, with regard to height, length, and width, are similar, the tubercles are nearly as prominent as in ordinary specimens of that species; but instead of three rounded tubercles on the latero-anterior margin, there are two rather sharp but short spines, the posterior being the larger. These spines differ from those of *X. bispinosa* in not being depressed, in being considerably shorter, and not in the slightest degree reflexed. I believe it to be a variety only of *X. Leachii;* but it appears desirable to call attention to it, as it comes from Alum Bay, in the Isle of Wight, a locality so remote from that in which the species just named is usually found. I have given a figure of it,* for the sake of future identification.

*Genus*—XANTHILITES, *mihi.*

*Char. Gen. Testa* pauló latior quam longior, margine latero-anteriore brevi, quadridentato; regionibus distinctis. *Fossæ antennariæ* obliquæ. *Antennæ internæ* articulo basali, unà cum illo antennarum externarum, hiatum orbitæ claudente. *Pedes antici* magni, robusti, digitis acutis, ferè inermibus; *reliqui* subcylindrici, læves. *Abdomen* MARIS ——? FŒMINÆ ellipticum, articulis omnibus separatis.

Sp. unica. XANTHILITES BOWERBANKII, *mihi.*—Plate II, figs. 2—6.

*Descr.* Carapace almost as long as it is broad; nearly horizontal from side to side, the anterior third considerably curved downwards; the front somewhat projecting, obscurely bilobed; latero-anterior margin very short, having four processes, of which the anterior two are very short and somewhat quadrate, the posterior obtusely triangular and more projecting; latero-posterior margin very short, obliquely truncate; posterior margin with an elevated border, which is separated from the rest of the carapace by a distinct groove; regions very distinct, and coarsely granulated, the furrows rather

* Plate I, fig. 10.

deep and quite smooth; epigastric lobes small, and scarcely distinct from the protogastric, which are large, and separated by the long, narrow process of the mesogastric; this is of a general pentagonal form, and is divided from the metagastric by an arched furrow; the urogastric lobe is not distinguishable from the metagastric; cardiac region pentagonal; hepatic region with a rounded elevation, the hepatico-branchial furrow very broad and distinct; branchial region large, the gastro-branchial furrow very deep at the junction of the gastric and cardiac regions; the epibranchial lobe elevated, with a distinct lobule adjoining the urogastric; mesobranchial very small and distinct; metabranchial obliquely truncated at its outer margin; orbits of moderate size, directed outwards, the hiatus filled jointly by the basal articulation of the external and the outer edge of that of the internal antennæ, the latter large and triangular, the former small and quadrate; epistome with a triangular process joining the front, and thus, as usual, separating the two antennary fossæ; external footjaws with the inner stalk elongate, straight, and narrow. As all the specimens which have come under my observation were much broken at this part, I have been unable to ascertain any further particulars of the structure of these important organs. Anterior legs very large, unequal; the wrist and hand partially granulated; the fingers of moderate strength, slightly grooved longitudinally, and with scarcely any tubercles on the opposing edges; they have strikingly the appearance of having been of a different colour from the rest of the body, a peculiarity which obtains in the recent genus *Xantho*, and which affords an interesting collateral indication of the relation of the two genera. The ambulatory feet rounded, and without any armature. Abdomen in the female elliptical, with a longitudinal furrow on each side; all the segments separate. All the specimens which I have seen being females, I can give no account of the male abdomen.

Length of the carapace, 1·5 inch; breadth, 1·8 inch.

*Obs.* The most obvious relation of this genus is to *Xantho*;* and its affinities to this genus are much more considerable than are those of *Xanthopsis*. It differs, however, from that form in some particulars, which appear quite sufficient to justify its generic distinction. The carapace is much longer in proportion to its breadth, and although equally flat from side to side, the anterior part is much more curved downwards; the external footjaws are proportionally much narrower, and the hiatus of the orbits, instead of being closed exclusively by the basal joint of the external antennæ, are partially closed also by that of the internal.

The specimens are numerous in the collections of Mr. Bowerbank and Mr. Wetherell, and there are a few in the British Museum. These are, I believe, exclusively, from the Isle of Sheppey; and I have seen some mutilated and worn specimens from Southend, in the collection of Mr. Prestwich.

* The species of *Xantho* to which it is most nearly allied appears to me to be *X. affinis* of De Haan, 'Faun. Japon. Crust.,' t. xiii, fig. 8.

This is the only known species of the genus, and I have the pleasure of dedicating it to my friend Mr. Bowerbank, to whom I am indebted for having, with his accustomed liberality, placed the whole of his fine collection of these fossils at my disposal.

*Genus*—PLAGIOLOPHUS, *Bell.*

*Char. Gen.* *Testa* transversa, ovata, regionibus distinctis, fronte prominente. *Oculi* subdistantes. *Orbitæ* suprà bifissæ, usque ad medium regionis hepaticæ extendentes. *Antennæ externæ* minimæ, articulo basali hiatum orbitæ claudente; *internæ* articulo basali triangulo, gibbo. *Pedipalpi externi* longitudinaliter bi-sulcati. *Pedes antici* mediocres, manu triquetrâ, digitis elongatis, digito immobili tuberculo armato, altero inermi. *Abdomen* MARIS articulis à tertio ad quintum unitis; FŒMINÆ ——?

Species unica. PLAGIOLOPHUS WETHERELLI, *mihi.* Plate II, figs. 7—13.

*Descr.* Carapace about one fifth or one sixth broader than long, widest at about one third from the front; latero-anterior margin very short, with five processes, of which the orbital is inconspicuous, the first hepatic very small, the second hepatic a little larger, flattened and triangular; the epibranchial the largest of all, conical; and the mesobranchial of similar form to this, but much less prominent and more distant from the former than any of the others; front somewhat projecting, rounded, with a longitudinal groove; the regions of the carapace and their lobes very distinct, each with a considerable elevation, which is strongly and closely granulated, the intervening furrows broad and perfectly smooth; gastric region of the usual size and form in the Canceridæ; the epigastric lobes small, but conspicuous, and close to the front; the protogastric rounded and very broad, and separated from each other by an elongated process of the mesogastric, which reaches nearly to the front; the mesogastric distinguished from the metagastric only by a slight notch on each side; cardiac region with a transverse ridge; hepatic region rather large, gibbous in the centre; branchial regions with two transverse elevations, the first across the epibranchial lobe, curved downwards towards the cardiac region, the second across the metabranchial, and forming, with the raised band of the epicardiac lobe, a continuous ridge extending almost across the carapace; mesobranchial lobe extremely small; posterior margin of the carapace with a raised border; orbits opening directly forwards, and extending outwards as far as the middle of the hepatic region; the superior ridge granulated, and with two fissures; the antennal region is more or less mutilated in all the specimens I have seen, but enough has remained to afford a probable conjecture as to the direction and relations of the antennæ; the basal joint of the antennules is perfect on each side in one specimen, and is of an elongate (transverse) triangular figure, and

gibbous on the surface; the external antennæ are not sufficiently perfect in any specimen to enable me to say more than that the basal joint probably fills the hiatus of the orbit; epistome rhomboidal; external footjaws twice as long as broad, and deeply grooved longitudinally; the abdomen exists in only one specimen, a male; it has the usual hastate form, and the third, fourth, and fifth joints are united; it is broadest at the junction of the third and fourth joints; anterior legs twice and a half the length of the carapace, smooth and polished; the wrist pentagonal, the hand somewhat carinated above, the fingers nearly as long as the hand, the immoveable one with a single projecting tooth or tubercle on the opposing edge, the moveable one without any armature; remaining feet quite simple and smooth.

Dimensions of largest specimen: length of carapace, 0·9 inch; breadth, 1·1 inch.

*Obs.* I have found considerable difficulty in satisfying myself respecting the affinities of this remarkable form. In most respects, however, and those especially which are to be regarded as the most important indications of relationship, it approaches the typical *Canceridæ*. The structure of the antennal region, the form of the external footjaws, the figure of the carapace, and the arrangement of the abdominal segments of the male, are similar to those of that family; but the distance of the orbits, extending as they do on each side as far as the middle of the hepatic region, indicate a marked approximation to the tribe of the "Catametopa" of Milne Edwards. Perhaps its nearest affinity is to *Eriphia*, and between this genus and the Thelphusadæ. The mutilated state of the antennary organs, however, forbids my stating this with certainty.

Numerous specimens exist in the collections of Mr. Bowerbank, of Mr. Wetherell, of Mr. Prestwich, and in my own; and there is a beautiful series in the British Museum. They are all, as far as I have ascertained, from Sheppey and Southend. Numbers of them are very small, and highly pyritic, some even having throughout a metallic lustre.

### *Family*—PORTUNIDÆ.

#### *Genus*—Portunites, *Bell.*

*Char. Gen.* *Testa* dimidio latior quam longior, depressa, margine latero-anteriore quinque-dentato, dente posteriore reliquis longiore. *Orbitæ* suprà bifissæ. *Pedipalpi externi* longitudinalitér sulcati. *Pedes antici* breves, robusti, inermes, digitis tuberculatis; *reliqui* graciles, læves (*par quintum*, anne ad natandum formatum?). *Abdomen* MARIS hastatum, articulis a tertio ad quintum unitis; FŒMINÆ ovatum, articulis omnibus separatis.

Species unica. PORTUNITES INCERTA, *mihi*. Plate III, figs. 1—5.

*Descr.* Carapace broader than it is long, in the proportion of three to two, much flattened in the adult state, more elevated when young; the surface granulated; the regions distinct, the separating furrows rather broad and generally free from granulations; gastric region with the lobes very distinct; epigastric small and inconspicuous; protogastric considerably raised, rounded, and separated from each other by a narrow process of the mesogastric which extends forwards nearly to the front; mesogastric and metagastric lobes continuous with each other, and forming together an elongated pentagon; urogastric short, separated from the former by a slight depression; cardiac region with a broad but low elevation on the anterior lobe; hepatic regions rather large, with a slight transverse elevation; branchial regions with the epibranchial lobe curved, narrow, and somewhat raised, extending from the metagastric to the lateral margin; the metabranchial portion traversed by a straight longitudinal ridge, against the outer side of which the fifth leg rests when turned over the back; a smooth depression just within the posterior margin, front entire; latero-anterior margin with the normal number of teeth (five), of which the fifth is the longest, triangular and pointed; orbits oval, extending outwards as far as the middle of the hepatic region, with two fissures above, and apparently none beneath; epistome rhomboidal; external footjaws longitudinally furrowed; anterior legs short and robust; the arm smooth, the wrist with a strong tubercle on the inner anterior angle, the hand slightly rugose, the outer margin slightly bicarinated, and with another inconspicuous carina on the upper side; fingers strong, longitudinally grooved, with tubercles on the opposed edges; the remaining legs slender, smooth, the terminal joint lost in all the specimens observed; male abdomen hastate, with the third, fourth, and fifth joints united; the female abdomen oval, with the whole of the joints separated.

Length of carapace, 1·2 inch ; breadth, 0·9 inch.

*Obs.* I have ventured to consider as nearly allied to *Portunus* a species, a considerable number of specimens of which are in the British Museum, and in the collections of Mr. Bowerbank and Mr. Wetherell, and in my own, all of which I believe are from the Isle of Sheppey. They are too much mutilated or otherwise imperfect to enable me with any absolute certainty to pronounce upon its generic relations, but the resemblance to *Portunus* is sufficiently obvious to warrant its location in the same family, and in no very remote situation from the typical forms. The absence of the terminal joint of the fifth pair of legs in all the specimens observed, prevents our ascertaining how far the natatorial habits indicated by the general organization would be borne out by the structure of that essential element. The whole of the posterior pairs of legs, as far as

regards those joints which remain, are all simple and somewhat rounded, having no appearance of the flattened, paddle-shaped form, which is an obvious feature in most of the Portunidæ. The flatness of the carapace, its form and sculpture, and the number of marginal processes are, however, in perfect coincidence with the structure of that family; and there is another incidental peculiarity which confirms this view, the habit, namely, of turning the hinder leg over the back when not employed, as is seen in the figure;* and this habit is, as it were, provided for by a longitudinal ridge running the whole length of the metabranchial lobe, against which the third or principal joint of the leg rests; a peculiarity which I do not remember to have seen in any recent form.

## Sub-Order—CATAMETOPA.

### *Family*—THELPHUSADÆ?

#### *Genus*—ŒDISOMA, *Bell.*

Species unica. ŒDISOMA AMBIGUUM, *mihi.* Plate III, figs. 6, 7.

*Descr.* The only certain specimen I have seen of this singular little Crustacean is in the collection of Mr. Bowerbank, from Sheppey, and consists of a tolerably perfect body, but without limbs or abdomen. The carapace is perfectly smooth, its general form ovoid, the latero-anterior and latero-posterior margin smooth, rounded, and without armature; the gastric region distinct, the protogastric lobes rounded, the meso- and meta-gastric undistinguished, and forming together an elongate pentagon; cardiac region somewhat rhomboidal; hepatic region extremely small; branchial very largely developed and tumid. Orbits large, oval, opening directly forwards, and extending laterally to within a fourth of the half breadth of the carapace on each side; the epistome is regularly rhomboidal; the external footjaws appear to have been sculptured, but the worn state of the specimen prevents the details or even the general form of these parts from being made out. The remains of the basal portion of the antennæ only indicate that these organs were of large size, and that they closed the hiatus of the orbit.

Length of carapace, 0·3 inch; breadth, 0·5 inch nearly.

*Obs.* These are the meagre data on which I have ventured to found the present genus. The little specimen certainly belongs to no known generic form, and even its family affinities are not very obvious. I have, however, ventured to give it a provisional place among the Thelphusadæ, which the occurrence of more perfect specimens may at some future time either correct or confirm.

* Plate II, fig. 1.

*Family*—CALAPPADÆ.

*Genus*—CAMPYLOSTOMA, *Bell.*

Species unica. CAMPYLOSTOMA MATUTIFORME, *mihi.* Plate III, figs. 8—10.

*Descr.* Carapace somewhat broader than it is long; the surface uniformly and finely granulated; the front with two teeth, the upper margin of the orbit with three, the inner one placed just above the frontal, a rather deep notch between this and the second, the third or external-angular rather small, forming the first of the five latero-anterior series; the second, third, and fourth of these are triangular, of nearly equal size, and with equal interspaces; the fifth much longer than the others, and probably produced into a long spine, the extremity of which is broken off in all the specimens examined.* The latero-posterior margin oblique, very slightly curved; the posterior margin a little hollowed at the middle; the regions of the carapace are rather indistinct; there are twelve tubercles on the surface, many of which become obsolete by age; of these there are five in a straight line across the anterior part of the carapace, *au niveau* with the third latero-anterior tooth; a large one on the mesogastric lobe, a smaller one on each side of it on the metagastric, a small one on the urogastric, the largest of all on the epicardiac, and a small one on the metacardiac: there is also a distinct one just within the latero-posterior margin on the metabranchial; a rounded, longitudinal ridge on each side, extends nearly the whole length of the carapace, and a groove lies between these and the central ridge on which the median tubercles are placed. The orbits are rather long, and somewhat open upwards; the pterygostomian process is broad, irregularly granulated, and has a broad, prominent ridge within the outer margin, and an inner parallel ridge with an intervening sulcus; the footjaws are wholly wanting in all the specimens I have seen excepting one, and in this only the second joint of the inner footstalk remains; this is elongate, linear, and straight; the buccal opening is narrowed forwards in a curved line, each side forming the segment of a circle; thus the opening is not triangular and pointed as in those forms to which this species appears to be most nearly allied.

Length of carapace, 1·3 inch; breadth, 1·7 inch.

*Obs.* All the parts, excepting those above described, are destroyed in all the specimens which I have had an opportunity of observing; and, from this circumstance, I have found considerable difficulty in coming to any satisfactory conclusion respecting the affinities of this species, and the defective state of the specimens has also prevented

* In one individual, of which I have given a figure, this part is evidently unnaturally developed. See Plate III, fig. 9.

me from giving any detailed generic character. I was led, however, from the general form of the carapace, the great similarity of its granulations, the identity of the tubercles on the surface, and of the teeth on the latero-anterior margin, and the form and direction of the orbits, to believe that it must be nearly related to the recent genus *Matuta*.

It differs, however, from that genus in the structure of the outer footjaws, which in the recent form are acutely triangular, being broad at the base, and extending forwards to an acute apex, of which figure the second joint forms a continuous part; whilst in the fossil genus, this, the only remaining portion of those organs, is linear, elongate, and rounded; in this character it also deviates from the group to which *Matuta* belongs. Notwithstanding this discrepancy, however, the narrowing of the buccal opening forwards, in an outline which as far as it is perfect in the specimen is sufficiently similar to that in *Matuta*, indicates a close approach to the family type, and in the unfortunate absence of all other parts, particularly of the limbs, which in this group are so characteristic, I felt justified in giving it conditionally a station amongst the Oxystomata, and in the matutiform section of the family Calappadæ.

Specimens of this species are in the British Museum, and in the collections of Mr. Bowerbank and Mr. Wetherell, and are all from the Isle of Sheppey.

## Sub-Order—OXYSTOMATA.

### *Family*—CORYSTIDÆ.

#### *Genus*—Cyclocorystes, *Bell.*

Species unica. Cyclocorystes pulchellus, *mihi*. Plate IV, figs. 1, 2.

*Descr.* Carapace nearly circular, somewhat contracted posteriorly; front advanced, horizontal, broad, slightly waved and minutely emarginate, without any armature; latero-anterior margin with a few very small, irregular, granulated teeth; latero-posterior margin rounded (posterior margin broken away in the only specimen known); regions flattened, distinctly and evenly granulated, the separating furrows smooth, and a round smooth patch between the hepatic and branchial regions, and another between the epibranchial and metabranchial lobes; frontal and orbital margins, and the pterygostomian processes granulated; gastric region separated by a broad, smooth furrow from the front. Protogastric lobes separated from each other by a long, linear, granulated process of the mesogastric; cardiac region pentagonal. Orbits nearly round, open above, without any fissure, the margins even and simple, the hiatus at the inner angle small, and probably filled by the basal joint of the external antennæ; antennary fossæ transverse, the roof even

and straight, formed by the projecting front; basal joint of the internal antennæ pear-shaped, gibbous, and granulated.

Length of carapace, 0·7 inch nearly; breadth, 0·7 inch.

*Obs.* The only specimen known of this beautiful species is in the collection of Mr. Wetherell, and was found at Holloway. The carapace only remains, but this is perfect excepting the extreme posterior margin. Of the important orbital and antennary regions there exist only the orbits, the antennary fossæ (imperfect), and the basal joint of the internal antennæ. The affinities of this form, as far as indicated by the character of the carapace, is clearly to the family of Corystidæ, and it is probably not far remote from *Atelecyclus;* but it differs from that genus, and from all others of the family in several particulars; in the more circular and circumscribed orbit, indicating short ocular peduncles, a narrower hiatus of the orbit, probably filled by the basal joint of the external antennæ; transverse antennary fossæ, with a distinct, short, solid, basal joint of the antennules, and a horizontal, plain, and unarmed front. The latter part, in every known species of *Atelecyclus*, the genus to which the present form appears, *primâ facie*, to be most nearly allied, is quinque-dentate, the three middle teeth being the most prominent. The orbits too, are, in the recent form, much less entire, and the fissures both above and below are large and deep. These characters indicate an approach to some of the Canceridæ, and especially remind us of some of the more circular forms of *Xantho*, as, for example, *X. integer* of De Haan, to which, however, its relation is more apparent than real.

The above observations on the affinities of this fossil, must be taken as merely provisional, and the discovery of more perfect specimens may require them to be corrected.

Order—*ANOMURA*?

Sub-Order—APTERURA?

*Family*— (?)

*Genus*—Goniochele, *Bell.*

*Char. Gen. Testa* hexagona, latior quam longior. *Orbitæ* latæ, apertæ, suprà dentatæ, margine inferiore integerrimo, semicirculari. *Pedes antici* validi, manu compressâ, obtrigonâ, digito mobili contra marginem anteriorem obliquè truncatum, apposito; *reliqui* graciles; posteriores parvi, supra dorsum retroversi. *Abdomen* in utroque sexu segmentis omnibus separatis; maris lineare, fœminæ ovale.

Species unica. GONIOCHELE ANGULATA, *mihi*. Plate IV, figs. 3—9.

*Descr.* The carapace of this ambiguous and anomalous species is irregularly hexagonal, rather flat, very deep, broader than it is long, the surface uniformly covered with distinct granulations; the regions distinct and elevated; the front projecting, toothed; the upper margin of the orbit furnished with three teeth, exclusive of that of the exterior angle (or first latero-anterior); between the first and second orbital teeth is a deep notch; the orbit is broad and open, smooth and polished within, the inferior margin entire, semicircular, and terminating outwards in a strong tooth; latero-anterior margin straight, and furnished with the normal number of teeth; the first (external orbital) triangular, projecting; the second and third (the two hepatic) very small and inconspicuous; the fourth (epibranchial) much larger than the foregoing, but not so large as the fifth, which forms a broad triangular spine, from which the latero-posterior margin extends in a straight line, to meet the posterior margin, which is somewhat waved, and forms a raised border; lobes of the gastric region very distinct and raised; the mesogastric somewhat hastate, and extending anteriorly in a narrow process to the front; the urogastric transverse, slightly curved, and longitudinally striated; the cardiac region raised towards the middle, the epicardiac lobe with a distinct, rounded, and conspicuous tubercle on each side, by which this species may be at once distinguished from every other; the metacardiac lobe with a double tubercle on the anterior portion, and a single one behind; hepatic region elevated on the centre; the branchial with a broad, longitudinal, raised portion, almost continuous with the raised epigastric, crossed near the middle of the carapace by a transverse ridge. The pterygostomian process and lateral portion of the carapace are perpendicular and very deep, with a broad, smooth, longitudinal furrow on the upper portion, and a granulated area beneath; the oral opening nearly square. The eyes, antennæ, and footjaws are absent in every specimen I have seen. The abdomen in the male is narrow, linear, the joints all separate, and each segment gibbous in the middle. In the female it is oval, all the segments separate, and raised in the middle. The most remarkable structure is that of the anterior legs, and particularly that of the chelæ. The whole limb is considerably compressed; the arm much broader anteriorly, tuberculated, with a smooth, longitudinal furrow near the outer margin, which is evenly curved and armed with four or five teeth; the wrist tuberculated; furrowed, and the margin marked with four conspicuous angles; the hand triangular, as broad at the anterior margin as it is long, the outer margin with ten teeth, the upper face with a large, smooth, concave, triangular surface, bordered interiorly by a longitudinal, double, granulated carina; the anterior margin very long, oblique, toothed, and opposed throughout its length to the moveable finger, which is narrow, somewhat falcate and toothed at both edges. From the few fragments which exist of the remaining feet, it appears that they

diminish in size pretty regularly from the second to the fifth pairs, that they are generally slender and smooth, and that the fifth pair are turned upwards over the back, as in so many of the Anomurous forms.

Length of carapace 1·7 inch; breadth, 2 inches.

*Obs.* It has been very difficult to assign to this species its relation to any of the known families of Crustacea, nor is it even certain whether I am right in placing it amongst the *Anomura*. I have been led to this opinion, however, by several points in its structure which approximate to those found in many forms of that group; particularly the large open orbits and the small size and dorsal direction of the posterior pair of feet. This latter character is implied from the first joint only of the feet, the situation of which in the two specimens in which I have seen them, is unequivocal.* The remarkable structure of the hand is, as far as I know, without any parallel in the whole class. The hand is so produced on its lower side towards the anterior part, as to occupy the position and to bear the function, also, of that process which is commonly called the immoveable finger, and it is opposed the whole length of its anterior margin to the finger which is bent down so as to meet it. The nearest approach to this structure in a recent form with which I am acquainted, is in the *Ranina*, in which, however, this abnormal condition is much less considerable. There is also an approach to a similar structure in the Eocene *Archæocarabus*.

There are numerous specimens both in Mr. Bowerbank's and Mr. Wetherell's collection, as well as some fine ones in the British Museum, derived, I believe, wholly from Sheppey.

## Order—*ANOMURA.*

## Sub-Order—APTERURA.

## *Family*—DROMIADÆ.

### *Genus*—Dromilites, *Edwards.*

*Char. Gen. Testa* suborbicularis, posticé latior, fronte incurvo; regionibus distinctis, branchiali maximâ, in partes duas sulco et carinâ transversè divisâ, quarum posterior rugosa, ad mediam testam ferè extendens. *Pedipalpi externi* oris aperturam implentes, caule exteriore subulato, plano; caulis interioris articulo secundo paulò longiore quam latiore, tertio æquè quadrato. *Pedes antici* equales, testâ longiores, digito immobili apicem versus digitato; *pedes quartus et quintus* reliquis minores, supra dorsum reversi. *Abdomen* in utroque sexu segmentis omnibus separatis, segmento sexto apud angulum antico-exteriorem appendicè instructo.

* See figs. 4, 5.

I had ventured, in the absence of any very satisfactory evidence, to consider one of the species about to be described as identical with the Dromilites of Professor Milne Edwards; and Professor M'Coy, in his account of his "*Basinotopus Lamarckii*," has the following note.* "On recognizing at first the anomurous nature of this fossil, I thought it might be the generic type named Dromilites by Dr. Milne Edwards, in the number of 'l'Institut' for August 1837, from Sheppey; but having lately had the pleasure of showing him the specimen, I find that though clearly allied, they are yet distinct." Finding in the various collections which I have examined, numerous specimens of a Crustacean, answering so far the indication of Professor M'Coy, and whose evident affinity to the recent genus *Dromia* led me to believe that it must be identical with *Dromilites* of Dr. Edwards, and probably, also, with *Dromia Bucklandii* of the same author,† I wrote to that gentleman, and have been favoured by him with the loan of a beautiful drawing of his specimen, and am thus enabled to confirm my previous views as to the identity of the species with my own. I shall, therefore, be enabled for the first time to offer a full description of this interesting form; and I am also compelled to include M'Coy's *Basinotopus* in the same genus, which I am confident he would have done, had he had the opportunity of examining the specimens now before me.

The full description of the two known species of this genus will show that there can be no doubt whatever that it is a truly anomurous form. This is shown not only by the condition and situation of the fourth and fifth pairs of legs, but also by the existence of the two small intercalary pieces forming the appendages to the sixth segment of the abdomen, which, in their development, constitute the lateral elements of the caudal organ in the *Macrura*, and in those aberrant forms of *Anomura* which approach them, such as *Porcellana* and allied genera.

Its relation to the recent genus *Dromia* is also very obvious and highly interesting. The essential characters are, indeed, as far as can be judged by the specimens under observation, so similar, as to indicate a very close affinity, and to justify its being placed not only within the family Dromiadæ, but in close approximation to the typical genus. The general form of the carapace (with the exception that in the recent genus the anterior portion is the broader, whilst in the fossil form the reverse is the case), the direction and termination of the front, the structure of the footjaws, that of the legs, even to the denticulation of the claw, and that of the abdomen in each sex, exhibit this close relation; and there is another fact which confirms it in a very interesting manner, and that is the minute puncta which, in both species, are found to pervade every part of the surface of the body and limbs, excepting the extremities of the claws, proving that both the species of this extinct genus, like every known species of *Dromia*, was covered with hair, and that of a similar character. The appearance of these puncta is absolutely

* 'Ann. Nat. Hist.,' 1849, p. 167.

† 'Hist. nat. des Crust.,' ii, pp. 178-9.

identical in the fossil and recent forms, and they constitute, in both, the obvious means of attachment of the hairy clothing.

It differs from *Dromia* in the shape of the carapace, which in *Dromilites* is nearly orbicular, or rather broader posteriorly, whilst in *Dromia* it becomes abruptly narrowed from the latero-anterior margin backwards. The surface is more nodulated than in the recent form, and the marginal inequalities and projections are very different. The abdomen is much less broad in each sex. But the most remarkable distinction consists in the existence of the broad rugose posterior portion of the branchial region, which is strikingly dissimilar from the anterior portion, and distinctly separated from it. It will be seen in the description of *D. Lamarckii*, that this peculiarity is, in that species, carried to an extreme, and that this singular structure extends quite across the carapace, occupying continuously nearly its posterior half. Professor M'Coy states in one part of his description of *Basinotopus Lamarckii*, that this rugose area is situated behind all the other regions of the body. It consists, however, undoubtedly, of only the metabranchial lobes, which are developed to an extraordinary extent.

Dromilites Lamarckii. Plate V, figs. 1—9.

Testâ rugoso-scabrâ, paulò longiore quam latiore, regione cardiacâ bituberculatâ.

Inachus Lamarckii, *Desmarest*. Crust. foss., t. ix, figs. 15, 16, p. 116.
Basinotopus Lamarckii, *M'Coy*. Ann. Nat. Hist., 1849, p. 168.

*Descr.* Carapace everywhere rugose, and almost scabrous, a little longer than it is broad, moderately convex, in the male subdepressed; front with a short, triangular rostrum, somewhat inflected and channeled, with a small tooth above on each side, and a tubercle forming the inner angle of the orbit, another at its outer angle, the upper edge of the orbit slightly elevated; lateral margin with five rather long spines, including the extra-orbital, the fifth being rather more distant from the fourth than the anterior ones from each other; gastric region occupying nearly half the length of the carapace, tuberculated. The epi- and proto-gastric lobes with three tubercles on each side, forming a line which diverges backwards, thus bordering a triangle formed by the union of the mesogastric and metagastric, which extends forwards to the base of the rostrum; the mesogastric with several small tubercles, and the metagastric with two larger ones; the urogastric forming a narrow, transverse ridge, which extends laterally the whole breadth of the cardiac region; the latter is prominent, and has two strong tubercles in its anterior lobe, and the posterior is scarcely distinguishable from it, and becomes blended with the rugose portion of the branchial region; hepatic region small, circumscribed at its margin by the two anterior marginal spines, and bearing one or two small tubercles. The branchial regions very large, each divided transversely by a broad sulcus, and a prominent ridge extending

in a curved line from behind the cardiac region to the posterior lateral spine; the anterior portion, consisting of the epibranchial and mesobranchial lobes, is somewhat rugous, and bears two tubercles, of which the hinder one is the larger; the posterior portion, or metabranchial lobe, which is considerably the larger, is everywhere rough, but without tubercles, and that of each side meets the opposite so as to form a peculiar, large, rugous area, occupying the whole breadth of at least the posterior third of the carapace; the posterior margin is broadly emarginate, and slightly elevated. The pterygostomian processes are deep, tumid, and irregularly mammillated. In all the specimens I have seen, the parts about the antennary and oral regions are too much mutilated to afford any accurate indication of the structure of these parts; but from the fragments which exist, there is little doubt that they resemble essentially those in the *D. Bucklandi*. The anterior legs are equal, somewhat longer in proportion than in the other species, being nearly twice as long as the carapace, generally smooth, although less so than in *D. Bucklandi*. The wrist in the male is one third longer than it is broad; in other respects the proportions are nearly the same, and the remaining pairs of legs do not differ from it in any important respect. The abdomen in both sexes has all the segments separate; in the male it is of nearly equal breadth throughout its whole length, with a rounded, longitudinal ridge along the centre, and a sulcus on each side of it, which is also the case with that of the female, in which the segments are more nearly of equal breadth than in *D. Bucklandii*. The puncta of the surface both of the carapace and members, are no less universal and numerous than in that species, although from the greater roughness of the surface generally, they are much less conspicuous, and in some specimens and parts of others, very difficult to be detected. There can be no doubt, however, that this species, as well as the other, was, like their existing congeners, covered with hair.

Length of carapace, 1·4 inch; breadth, 1·2 inch.

This species is found in considerable abundance in Sheppey, as well as in other parts of the London Clay, particularly about Highgate, near Chalk Farm, &c. It appears to be one of the most generally distributed species found in the London Clay.

The location of this Crustacean in the genus *Inachus* by Desmarest, requires no observation. Its true position amongst the Anomura has been already shown by Professor M'Coy, and its generic relation to *Dromilites* is now, it is hoped, shown to be no less certain. It is an interesting fact, that there existed at the period of the deposit of the Eocene beds, such distinct representatives of one of the most remarkable types of the anomurous decapods, which are, at the same time, unmistakeably distinct in their generic characters. It is also worthy of notice, that the species now described shows a certain remote approach to the genus *Homola*, especially to the deep sea Mediterranean species *H. Cuvieri*, first described by Roux.*

* 'Crust. de la Mediter.,' t. vii.

DROMILITES BUCKLANDI, *Edwards*. Plate VI, figs. 1—11.

Testâ suborbiculatâ, anticè glabrâ, æquè longâ ac latâ; regione cardiacâ convexâ, non tuberculatâ.

DROMIA BUCKLANDI, *Edwards*. Hist. nat. des Crust., t. ii, p. 178.

*Descr. Adult.* Carapace suborbicular, as long as it is broad, considerably convex, minutely punctated, the front very much inflated, triangular, pointed, with two small projecting teeth above, and a sulcus between them; orbits directed obliquely backwards and outwards, the margin slightly raised; latero-anterior margin with two flattened, bidentate projections, one on the hepatic region, the other on the mesobranchial lobe, and a strong tooth with a smaller one behind it on the metabranchial, the whole constituting the normal number (five) of lateral teeth; gastric region very large, with two slight elevations on the protogastric lobes, one on each side the median line, and two larger rounded tubercles on the mesogastric, these four constituting the remaining elevations of the eight, which are found on this region in the young animal. Urogastric lobe very short, forming an almost linear, transverse piece, with slight indications of the small tubercles which occupy this part in the young state; cardiac region irregularly pentagonal, evenly raised towards the centre, sometimes with a slight depression on the raised portion; the posterior lobe very small, scarcely distinguishable from the metabranchial; hepatic region small, smooth, continuous with the gastric, without any line of demarcation; branchial region very large; the metabranchial distinctly separated from the anterior portion by a groove, which extends in a curve backwards between it and the cardiac region; the epibranchial lobe has two tubercles, and the mesobranchial is slightly raised; the metabranchial rugose, very broad, extending on each side towards the mesial line, where the two approximate so much as scarcely to be distinguishable one from the other, or from the small posterior cardiac lobe, which becomes, as it were, amalgamated with them. I have seen this remarkable approximation of the posterior portion of the two branchial regions carried in *D. Lamarckii* to a still greater extent; as, in that species, they unite intimately for their whole length, so as to form a continuous area, occupying nearly half of the whole carapace.

The whole of the specimens which have come under my observation have been mutilated, so that I have not had an opportunity of ascertaining the form of the under margin of the orbits, of the eyes, or of any portion of the antennary region; the external pedipalps, judging from a specimen in which this organ is tolerably perfect, has almost exactly the same form as in *Dromia*. The basal joint is narrow, of an irregular form, wider at the inner extremity; the outer stalk flattened, awl-shaped, and as long as the inner; the first joint of the inner stalk quadrate, rather longer than broad, the second quadrate; all quite smooth and polished. The anterior pair of legs equal, very smooth

and polished, and, like the rest of the crust in all parts, minutely punctate. The arm half as long again as it is broad, with a tubercle on its antero-interior angle, and a series of very small tubercles on the upper and under margin; the wrist as long as it is broad, with three prominent, sharp, flattened, triangular spines on the anterior margin, of which the inner one is the smallest; the hand smooth, convex, with a small tubercle near the articulation of the moveable finger; the immoveable finger becomes broader towards the extremity, where it is obliquely truncate, and very evenly seven-toothed; the moveable one toothless, curved, and pointed, the curved extremity meeting the oblique, toothed portion of the other; the hand is marked with very regular, minute marblings, in longitudinal lines, which are of two distinct hues, the lines and transverse markings being pale, the interspaces darker brown, and where a portion of the crust has been broken, the subjacent cast, probably covered still with fossilized colouring membrane, exhibits a similar pattern. The remaining feet, as far as can be ascertained from the specimens before me, are of moderate length, smooth, somewhat triedral; and the posterior two pairs smaller; these were, doubtless, reverted over the back when living, as in the recent allied forms. Abdomen in both sexes with all the segments distinct and separate; that of the male rather narrow, broader at the base, the first six segments broader than long, in a diminishing ratio forwards; the seventh nearly twice as long as broad, rounded at the anterior margin; the sixth segment with a small intercalary piece on each side at the anterior angle. In the female the abdomen is twice as broad as in the male, and the intercalary appendages to the sixth segment larger; the terminal joint semi-oval, as broad as it is long.

Length and breadth of carapace, 1·5 inch.

The young state of this species differs so much from the adult, that, but for the comparison of a series of specimens exhibiting its consecutive conditions, it might readily be taken for a distinct species. Many of the tuberosities which are distinct, and even prominent in the young animal, are lowered, expanded, and some of them even lost, in the adult. The gastric region has eight distinct elevations, of which only the anterior and posterior pairs (the epi- and meta-gastric), are conspicuous in the adult. The six principal ones form a transverse hexagon, the two posterior being considerably larger and more prominent than the others. The urogastric lobe consists of a linear, transverse series of five small tubercles, which ultimately become nearly obsolete; the tubercles of the anterior portion of the branchial are two pairs, the posterior ones being the larger; and the epicardiac is wholly occupied by one large, rounded elevation; the posterior rugose portion of the branchial is also more regularly elevated transversely, and the sulcus separating this from the anterior is less deep and distinct than in the adult; the metacardiac lobe is small, slightly elevated posteriorly, and polished.

There is a single specimen of this species in the British Museum, and they are numerous in the collections of Mr. Bowerbank and Mr. Wetherell. I have given figures of specimens of various ages, for the purpose of comparison.

ORDER—*MACRURA.*

Sub-Order—CATAPHRACTA.

*Family*—SCYLLARIDÆ.

*Genus*—THENOPS, *Bell.*

*Char. Gen. Testa* depressa, sinu cervicali profundo in partes inæquales divisa, margine anteriore quinque-lobato, rostro prominente, e dentibus binis, conicis, fortibus formato. *Antennæ externæ* planæ, margine exteriore fortiter dentato. *Pedipalpi externi* graciles, filiformes. *Abdomen* triedrum, carinatum.

Species unica. THENOPS SCYLLARIFORMIS, *mihi.* Plate VII, figs. 1—8.

*Descr.* Carapace flattened, the surface coarsely granulated, divided at about one third from the front by the cervical furrow, which is very deep, strongly curved forwards; the anterior portion or cephalic arch with a short, central, longitudinal furrow, commencing at the cervical sulcus, and circumscribed by two carinæ, which converge forwards into a short carina which is bordered by two others; on each side a strong curved ridge runs from the anterior margin backwards to the cervical furrow. The central portion of the margin is furnished with four or five large flattened lobes, the exterior portion denticulate, and terminating outwards in an acute angle; the rostrum arises immediately under and in front of the median lobes of the carapace, and consists of two very strong, conical, acute, slightly divaricating teeth; the lateral margin thick, strongly granulated, and toothed; the post-cervical portion or scapular arch is flat, and has three carinæ, one central, the others marginal; the granulations of the surface coarser than those of the anterior portion, and almost squamiform. The external antennæ have the remarkable conformation peculiar to the family Scyllaridæ, being broad and much flattened, the external margin strongly toothed; the abdomen is carinated and tectiform, the segments coarsely punctate, and each with an obtusely triangular, transverse ridge; the epimera denticulate on the margin. The caudal appendages are either wholly wanting, or in too mutilated a state, in all the specimens I have seen, to admit of any description. The legs are compressed, the anterior onés considerably the largest; the external pedipalps slender, filiform, and curved inwards towards the extremity; the thorax forms an acute triangle, and there are a pair of deep depressions at the junction of the different segments.

Length of the whole animal, 7 to 8 inches; length of carapace, 3 inches; breadth of carapace, $1\frac{1}{2}$ inch.

*Obs.* There can be no possible doubt of the relation of this very interesting fossil. It possesses all the distinctive characters of the family Scyllaridæ, as represented by the three recent genera *Scyllarus*, *Thenus*, and *Ibacus*. In especial, it resembles them in that peculiarity in the structure of the external antennæ, which constitutes one of the most interesting examples of morphology in the whole class. These organs, instead of being developed, as in all the other groups of the order, into long, slender, multi-articulate filaments, to which the basal joints serve only as strong supports and means of attachment, are in the present family deprived of the terminal filament altogether, and the basal joints are developed into very broad, flat implements, which doubtless serve the purpose of shovels, to enable the animal to scuttle under the sand or mud in which they probably pass the greater portion of their time. Although in all the numerous specimens of the present species which I have seen, these organs are incomplete, there are sufficient fragments to enable me to confirm the decided impression of its true relations which I first received from the examination of other portions of the animal.

Of the three recent genera of Scyllaridæ the present fossil most resembles the genus *Scyllarus* in its general proportions, and particularly in the nearly parallel sides of the abdomen; but approaches more nearly to *Thenus* in the very strong, conical, prominent, and slightly divaricating teeth of the rostrum. It differs strikingly from all the recent forms in the distinctness, depth, and situation of the cervical sulcus of the carapace, which is comparatively indistinct in all the recent species, but in this constitutes a very marked character, and is so deep as to occasion the carapace to be often found broken across at that part. The joints of the external antennæ resemble those of *Scyllarus* in their extension forwards, in which respect they greatly exceed those of both *Ibacus* and *Thenus*. I have not been able to discover the eyes, nor the place for them, in any of the specimens I have seen, and as the anterior margin has been very completely examined, I presume that they are placed at the extreme external angle, as in *Thenus*, and not just within the angle, as in *Scyllarus*, and still less probably midway between it and the rostrum, as in *Ibacus*. In either of the latter cases they could not have escaped observation.

The specimens, both from the Isle of Sheppey, and the northern suburbs of London, and especially from the latter locality, are very numerous in the British Museum, and in the collections of Mr. Bowerbank and Mr. Wetherell; there are also two fragments in the Hunterian collection in the museum of the Royal College of Surgeons, and Monsieur le Capitaine le Hon has lately shown me a specimen consisting of a few segments of an abdomen, which I instantly recognised as belonging to this species. It was from the "Sable" of the neighbourhood of Brussels.

*Genus*—SCYLLARIDIA, *Bell.*

*Char. Gen. Testa* æqué longa ac lata, sulco cervicali profundo, rostro dilatato, bidentato. *Oculi* prope angulum antico-lateralem positi. *Abdomen* medio elevatum, haud carinatum.

Species unica. SCYLLARIDIA KOENIGII, *mihi.* Plate VIII, figs. 1—3.

CANCER (SCYLLARUS?) TUBERCULATUS, *König.* Icon. Foss. Sect., fig. 54.
XANTHOPSIS TUBERCULATUS, *Morris.* Cat. Brit. Foss., 1854, p. 116.

*Descr.* Carapace very nearly as broad as long, coarsely granulated; frontal margin nearly straight, denticulated; the rostrum flattened, somewhat expanded, bidentate; orbits placed near the external angle, but not at the extremity as in *Thenus;* upper and inner orbital margin elevated; cervical furrow deep, smooth, commencing on the lateral margin, about one fourth from the anterior angle, and passing obliquely backwards to about the middle of the carapace; gastric region with an elevated ridge on the centre having two angular projections, of which the posterior is the more prominent, and a small tubercle on each side; cardiac region with a strong ridge similar to that of the gastric, terminating abruptly at the cervical furrow; branchial region with two slightly tuberculated ridges, the outer one marginal. Basal joints of the external antennæ broad and flattened, as in the other genera of this family; abdomen rounded, raised in the centre, but not carinated; the segments granulated, excepting on that portion of each which passes under the one in front of it.

In all the specimens yet discovered, the abdomen is bent under the thorax.

Length of carapace, 1·4 inch; breadth, 1·4 inch nearly.

*Obs.* All the specimens hitherto obtained of this species are from Sheppey. The original one, to which further allusion will presently be made, is in the British Museum. There are four in the collection of Mr. Bowerbank, and one in that of Mr. Wetherell. In all of these the limbs and the caudal extremity of the abdomen are either wholly wanting or existing only in unavailable fragments. There are, however, sufficiently perfect remains of other parts, to afford data for its association with *Thenops* in the family Scyllaridæ, and for its generic distinction from that and from the recent forms of the family. Its nearest approximation is to the recent genus *Scyllarus,* from which it is sufficiently distinct by the form of the rostrum, the depth and distinctness of the cervical furrow, and the rounded form of the abdomen. Its relation to that genus is, however,

very obvious in the position of the eyes, in which it differs from the other two recent genera of the family.

The literary history, if it may be so termed, of this species, is somewhat curious. A single specimen only was known to be in existence, until those above referred to were found to be contained in the rich collections of Mr. Bowerbank and Mr. Wetherell. That specimen is now, and has been for very many years, in the British Museum. It formed the subject of a description with a figure by the late M. König in his 'Icones Fossilium Sectiles,' under the name of *Scyllarus* (?) *tuberculatus*. This proves, on examination, as was first pointed out to me by Mr. Woodward, to be artificially made up; the whole surface of the carapace is fictitious, and the very tubercles* on which the name was founded exist only in obedience to the skill and trickery of the artist. All the distinctive characters, even of the family to which it belongs, are thus lost, but Mr. König with great acumen recognised its affinities from its general form, and named it as above. In Professor Morris's most useful and elaborate 'Catalogue' it is mistakenly referred to the Brachyurous genus *Xanthopsis*, as a synonym of *Z. nodosus*, of M'Coy, simply, as I presume, from its specific name *tuberculatus;* and this oversight probably arose from the specimen not having been seen, and the figure itself having been forgotten by the learned author.

The specific name, having been founded on an error, must be changed; and I have great pleasure in the opportunity afforded me of naming it after my old friend Mr. König, who first distinguished it, and appreciated its relations.

### *Family*—ASTACIDÆ.

#### *Genus*—Hoploparia, *M'Coy*.

*Char. Gen. Testa* subcompressa, lateribus latis; sulco cervicali profundo, latera versus abbreviato; sulco hepatico bifurcato, λ-formi; rostro subulato; processu supra-antennali semicylindraceo, basin squamæ antennæ externæ tegente. *Pedes antici* inæquales; *major* robustus, digitis fortiter tuberculatis; *alter* gracilis, digitis denticulis numerosis, subæqualibus, armatis: *pedes reliqui* gracillimi. *Abdomen* subcylindraceum, epimeris falcatis, acuminatis.

The very close affinity of this genus to *Homarus*, as exemplified in the common lobster, *H. vulgaris*, might lead the naturalist at first sight to consider the fossil species as scarcely generically distinct from the recent one; and the late Mr. George Sowerby has accordingly named and described one from the Greensand of Lyme Regis, as a true *Astacus*, from

* Mr. König's words are, "tubercula in utroque thoracis latere, duo."

which genus, at that time, *Homarus* was not considered distinct. This similarity is particularly striking in the larger London Clay species *Hoploparia gammaroides*, in which the anterior legs and the abdomen are almost identical in form with *Homarus*. A closer examination, however, will fully justify Professor M'Coy's separation of these fossils from all the recent forms of Astacidæ. The principal and most obvious distinctions are the following. The simple, awl-shaped rostrum, differing from that of *Homarus* and *Nephrops* in its not having any armature, and from that of *Astacus* in its form, which, in the latter, is rather broadly triangular; the deep cervical furrow terminating abruptly at its internal extremity, without reaching the margin of the carapace. A distinct, bifurcate furrow, called by Professor M'Coy the "λ-like cheek-furrow," but to which I have given the name of hepatic from its situation, and which does not exist in any recent species of Astacidæ that I have seen, excepting, in a much less conspicuous state, in *Nephrops Norvegicus*, and, as a mere indication, in an undescribed species of *Astacus* from Australia. The arched process immediately over the base of the external antennæ, the scale of which emerges immediately from beneath it, on which Professor M'Coy so much depended for its distinctive character, is scarcely different in any essential point from the same part in the recent genus *Nephrops*, as will be seen by referring to the figure of that part which I have given in Plate X, fig. 10. The armature, also, of the same part, upon which the generic name was founded, is equally similar. The extremities of the four pairs of ambulatory feet are wanting in every specimen I have seen of the different fossil species, so that it is impossible to determine whether or not the second and third pairs are didactyle, as in every recent species of the family. The fragments of the antennæ, which exist in several specimens in the collections of Mr. Bowerbank and Mr. Wetherell, exhibit a perfect resemblance to those of *Homarus*.

There are probably four species of this genus known. One described by Mr. George Sowerby as *Astacus longimanus*,* from the lowest Greensand of Lyme Regis; another, *Hoploparia prismatica*,† described by Professor M'Coy, from the Speeton Clay of Speeton, in Yorkshire; and two, also described by the same author, from the London Clay, *H. gammaroides*, and *H. Belli*.‡ I have not had an opportunity of comparing either the species from Lyme Regis, or that from Speeton, with those of the London Clay, but hope to be able to do so before the completion of the future portion of this work. Mr. Sowerby's figure of the former exceedingly resembles *H. Belli*, but is certainly not identical.

* 'Zool. Journ.,' ii, p. 493, t. xvii.
† 'Ann. Nat. Hist.,' l. c.
‡ Ibid.

HOPLOPARIA GAMMAROIDES, *M'Coy*. Plate VIII, figs. 4—6; Plate IX.

Pedibus anticis feré æqualibus, digitis utriusque tuberculis dentiformibus inæqualibus armatis. "Squille pétrifié, pyriteuse d'Angleterre." (Davila, Cat., vol. iii, p. 203, pl. v, K.)

HOPLOPARIA GAMMAROIDES, *M'Coy*. Ann. Nat. Hist., l. c. Morris, Cat. Brit. Foss., 2d edit., 1854, p. 109. Cat. Foss. Invert., Mus. Roy. Col. Surg., 1856, p. 176.

*Descr.* Carapace everywhere irregularly granulated, the granulations on the gastric region larger and somewhat equamiform, strongly granulated on the sides towards the fore part of the lateral margin; cervical furrow deep, extending only about half way towards the lateral margin, and situated somewhat further back than in the former species; hepatic furrow deep; rostrum deeply grooved and strongly bicarinate, with an elongated tubercle on each side of its base, and one small tubercle on each side below the first pair, near the edge of the orbit. "From a little behind the level of the orbit the cheek is elevated into a strong keel, with about three large spinous tubercles; cheeks prolonged as a semi-cylindrical sheath to the outer antennæ half the length of the rostrum."* Abdomen rounded, the segments smooth, but not polished, as in *H. Belli*, finely punctate, the first rather more strongly than the other; the epimeral plates broadly falcate, and formed as in *H. Belli*; the middle plate of the tail nearly as broad at the base as it is long, rounded posteriorly; the surface granulated and somewhat squamose, with a transverse elevation near the base, and two slightly diverging branches from it directed backwards. The first pair of legs very robust, one more so than the other, but the difference is much less than in *H. Belli*, and scarcely so much so as in the common lobster; the arm is elongate, rhomboidal, furnished with a strong spine at the outer anterior angle, and with three flattened ones on the inner margin; the wrist has three or four strong tubercles on the outer and upper surface, and a triangular spine on the inner margin; the hand is nearly smooth, and has three or four similar spines on the inner margin, and two strong tubercles near the base of the moveable finger. The fingers are in both the hands armed with several strong teeth on the opposing edges, together with many smaller ones, and in this respect the two claws are similar to each other, whilst in the former species, the armature of the two claws is totally different, as has been described. The rest of the legs are rather slender, smooth, somewhat compressed, but the terminal joints are wanting in all the specimens I have seen.

This is pre-eminently, but by no means exclusively, a Sheppey species. It is found very commonly in that locality, and numerous specimens exist in the collections in the British Museum, in that of Cambridge, in those of Mr. Bowerbank and Mr. Wetherell,

* M'Coy, *l. c.* [I have not observed this structure in any specimen I have examined.—T. B.]

and a remarkably beautiful one in the Hunterian Collection. The fine claws figured in Plate IX are in Mr. Wetherell's collection, and from Copenhagen Fields. It is about twice the dimensions of *H. Belli*, and more nearly approximates the common lobster than does that species. It is probable that it would form a very distinct section of the genus, if not actually generically distinct from the last-mentioned species, associated with *H. longimana* from the Greensand. It is remarkable that the first notice and figure of this species should have occurred in the Catalogue of a Frenchman's collection published nearly a century ago, and that it should have remained wholly undescribed in this country until the year 1849.

HOPLOPARIA BELLI, *M'Coy*. Plate X, figs. 1—9.

Pedibus anticis lævibus, gracilibus, minore filiformi, digitis minuté denticulatis. Abdomine polito.

HOPLOPARIA BELLI, *M'Coy*. Mag. Nat. Hist., 1849, p. 178. Morris, Cat. Brit. Foss., 2d edit., 1854, p. 109. Cat. Foss. Invert., Mus. Roy. Col. Surg., 1854, p. 177.

*Descr.* The carapace in this species is somewhat compressed, slightly incurved at the inferior margin, the outline of which forms nearly an accurate arc of a circle; the rostrum is awlshaped, acute, about one fourth the length of the carapace, with a slight groove, which at the base is interrupted by a small carina or elongated tubercle; there are two tubercles on each side of the anterior part of the carapace, just behind the upper margin of the orbits, and another on the process which covers the base of the antennal scale; this process is arched, minutely granulated at the margin, and partly embraces the origin of the antennal scale; this structure I have with much care and some difficulty cleared away in several specimens, sufficiently to show that in its general form and character it bears a considerable resemblance to the same part in *Homarus* and *Nephrops*, and none whatever to the ideal figure given by Professor M'Coy, in his paper already referred to, which is so incorrect as to be calculated to mislead as to the true organization and relations of the animal. The surface of the carapace is covered with very regular granulations of two sizes intermixed, the larger being the more numerous; towards the dorsal portion they become less prominent, and less regular in form, and are accompanied each by a depressed punctum; the cervical furrow is deep and smooth, and extends downwards to within a line of the margin; the hepatic sulcus is deep, narrow, of somewhat the shape of the Greek λ; the upper limb commencing at about one third from the centre of the back, and continuing nearly straight downwards, the anterior limb stretching forwards, slightly curved, and terminating near the root of the supra-antennal

process. Abdomen somewhat compressed, evenly rounded on the back part, and without any carina or other inequality of the surface; the segments polished and everywhere punctate, excepting that portion of each which slides under the margin of the one before it, which part is more highly polished, and almost wholly without puncta; the first segment is the narrowest, the second has the lateral or epimeral piece broad, nearly quadrate, with a sharp, triangular, hooked process at the posterior angle; the epimera of the third, fourth, and fifth segments are triangular, falcate, the inferior angle directed backwards, the sixth is very broad, and deeply notched for the attachment of the base of the appendages, forming the external portions of the tail; the seventh segment or central portion of the tail is semi-elliptical, evenly rounded at the posterior margin, with two slight ridges diverging forwards; the outer member of the tail curved, and divided transversely at about one third from the extremity, and with a slight longitudinal ridge; the inner member as broad as it is long, rounded, the posterior margin truncate, with a longitudinal ridge; anterior pair of legs unequal; both much more slender and less robust than in *H. gammaroides.* The arm is long, triquetrous, enlarging forwards, the wrist also elongate, with two or three tubercles near the anterior margin; the hand of the larger claw with a few triangular teeth on the inferior margin, the upper face with an even and obtuse ridge, extending its whole length, and continued along the immoveable finger to its extremity; the fingers of the larger claw are furnished with several strong tubercles, and numerous smaller ones; the smaller hand resembles the other in its general characters, but it is much more slender, less curved at the margins, and the fingers are armed only with numerous minute, nearly equal denticuli, without any larger tubercles; the remaining legs appear, from the fragments which have been observed, to be very slender, quite smooth, and polished.

*Obs.* In its proportions, the species appears to resemble *H. longimana* (Sp. Sowerby), of the Lower Greensand, before alluded to, much more nearly than its neighbour of the London Clay, *H. gammaroides,* which is, in all its proportions, more robust and solid than either of the others.

The polished surface of the abdomen, the regularly granulated carapace, and the general elegance of its form, render this species one of the most beautiful of the known fossil Crustacea. It is more frequently found in the northern suburbs of London, where it is very numerous, than in other localities, although there are several specimens both in Mr. Bowerbank's and Mr. Wetherell's collections from Sheppey. It is observable that the specimens obtained from the former locality are, almost universally, cleaner and more polished than those from the latter.

There is a specimen in Mr. Wetherell's collection, of which I give a figure in Plate X, fig. 9, which differs in some respects from the normal character of *H. Belli,*

the carapace being altogether more tumid, the granulations on the surface less regular and universal in their distribution, the cervical furrow deeper, and extending nearer to the margin of the carapace, and the hepatic furrow of a somewhat different form. As only a mutilated carapace of this character exists, I do not presume to treat it as a distinct species, and most probably it is, after all, only an accidentally abnormal condition of *H. Belli*.

*Genus*—Trachysoma, *Bell.*

Trachysoma scabrum, *mihi*. Plate X, fig. 11.

I have found it necessary to assign a distinct generic position to a form which differs from all others that I have seen, although, unfortunately, the only example of it yet discovered is a single specimen in Mr. Wetherell's collection, which consists exclusively of a broken and imperfect carapace, and a few undistinguishable fragments of the limbs. From these scanty data I can only give slight and provisional characters, which, however, with the figure, may be sufficient to enable future observers to identify the species, and more fully to describe it from more perfect specimens.

The carapace is long, apparently flattened at the sides (though this appearance may possibly arise from pressure, of which there are other unmistakeable indications), and the whole surface highly scabrous; the cervical furrow is deep and strongly marked, and runs in almost a straight line directly across the carapace; the "cephalic arch" or portion anterior to the cervical furrow, comprising the gastric and hepatic regions, occupies about one third of the length of the carapace, and is longitudinally marked with strong ridges and intermediate furrows, the latter being smooth, whilst the ridges resemble the general surface in being very rough, with numerous small, sharp tubercles; the "scapular arch," formed of the cardiac and branchial regions, has a diagonal furrow, which separates these two regions; the posterior margin is waved, and, like the lateral, has a distinct, raised border. A considerable piece of the antennal scale remains, which shows that it partook of the scabrous and almost spinous character of the other parts; and there are some fragments of several of the thoracic members, one of which appears to be a portion of the arm, which is less rough than the carapace, and one piece, which is probably a portion of one of the ambulatory legs, is quite smooth and polished.

Length of carapace, 1·3 inch.

I do not presume, upon such an imperfect basis, to offer any present suggestions as to the affinities of this species. It differs in so many respects from every known form, either extinct or existing, that we must wait for further data before any satisfactory opinion can be adopted.

The specimen was found in the tunnel near Chalk Farm.

*Family*—CRANGONIDÆ?

*Genus*—ARCHÆOCARABUS, *M'Coy.*

*Char. Gen.* *Testa* antice depressa, plana, margine anteriore recto, denticulato, rostro parvo, bidentato; sinu cervicali profundo, lato; posticé subcylindrica, regionibus branchialibus latissimis. *Oculi* grandes, reniformes, pedunculis angustioribus. *Pedes antici* magni, subcheliformes, digito mobili longo, curvo, ad marginem anteriorem manûs opposito. *Pedes reliqui* filiformes, inermes, subtriedri. *Abdomen* semicirculare, glabrum. *Sternum* segmentis in medio bituberculatis.

Species unica. ARCHÆOCARABUS BOWERBANKII, *M'Coy.* Plate XI, figs. 1—5.

ARCHÆOCARABUS BOWERBANKII, *M'Coy.* Ann. Nat. Hist., l. c.

*Descr.* Carapace about twice as long as it is broad, covered with oval, subsquamiform, flattened tubercles, their blunt apices directed forwards; cervical furrow deep and broad; the cephalic arch, or portion anterior to the cervical furrow, flattened, with a high, abrupt carina on each side, which is polished, and armed with two strong spines; the scapular arch or posterior portion of the carapace, with the tubercles much larger than those on the anterior portion, those on the back being the largest of all; the cardiac region elevated, the branchial very broad, wholly lateral, and placed almost perpendicularly; the branchio-cardiac furrow distinct, smooth, and polished. Abdomen, including the caudal fin, nearly twice as long as the carapace, semi-cylindrical, smooth, slightly punctated; epimeral pieces abruptly narrowed, triangular, falcate, curved backwards, and acute at the apex; lateral plates of the tail nearly three times as long as they are broad, slightly curved, granulated; anterior feet broad, compressed; the hand very broad, expanded towards the anterior extremity, with a broad, longitudinal depression; the anterior margin truncate, toothed, the extreme joint or moveable finger curved, longer than the anterior truncated margin of the hand, to which it is opposed for prehension; the arm compressed, broad, longer than the hand; the remaining legs nearly triedral, smooth, and polished; sternum triangular, contracted at the anterior part, each segment having a double tubercle in the centre. Eyes very large, reniform; the peduncle very short, and not one third as broad as the eye.

Length of the carapace, about 3 inches.

*Obs.* This beautiful and curious species was first made known by Professor M'Coy, in his paper on 'British Fossil Crustacea,' so often quoted. With regard to its supposed affinities, he has the following observations. "In all the characters of generic importance which I have seen in these fossils, they approach the recent *Palinuri* or spiny lobsters;" and he applies to it a generic name in consonance with this supposed relation. What are the characters in which the author has discovered this relation he does not inform us; but I have failed to find any such relation in the characters which have offered themselves in the numerous specimens which I have had an opportunity of examining. In the general rounded form of the abdomen it resembles the Palinuridæ, in common with the Astacidæ and many other families, particularly the Crangonidæ, with which I shall presently show its relation; but in the most important points in which the recent Palinuri agree amongst themselves, and differ from other genera, the present fossil species does not exhibit any such affinity. The front of the carapace does not possess any indication of the peculiar structure of that part in the recent genus, and this is especially obvious in the total absence of the two strong, projecting, supra-rostral spines, which exist in every known species of that family. To set aside, however, all minor considerations, the form of the anterior feet, a character so important in all this class, presents the most striking discrepancy between the two forms; instead of the simple termination of these limbs in a single acute joint, not differing from the terminal portion of the other feet, which is seen in all the recent species, the fossil animal has the remarkable development of this part which characterises the genus *Crangon*, but in a still more marked degree; the anterior margin of the hand being truncated abruptly, and forming an opposing line to the moveable finger, which in prehension would be applied to it in its whole length. I have on this account considered it as probably belonging to the family Crangonidæ, to which, it appears to me, this important character, in the absence of any striking discrepancy in other organs, indicates an obvious affinity. The name *Archæocarabus*, applied to it by Professor M'Coy, was therefore, as I conceive, founded upon a misapprehension of its true relations; but I have not presumed to change it, a step which is only allowable under extreme circumstances.

This must be considered as pre-eminently a Sheppey fossil; for, although occasionally found in the northern suburbs of London, the great majority of the specimens which have come under my observation, have been found in the former locality. They exist in the British Museum, in the Woodwardian Museum at Cambridge, in the Hunterian Museum, and in Mr. Bowerbank's collection, but from the very fragile texture of the crust, they are all much broken.

## SUPPLEMENTARY NOTICES AND CORRECTIONS.

XANTHOPSIS.—Since the earlier sheets of this work have been printed, my attention has been recalled to a letter from Professor Milne Edwards to Mr. Wetherell, with which the latter gentleman favoured me some time ago, in which the following passage occurs—"The original specimen of *Cancer Leachii*, described by Desmarest, has been recently given to our museum, and I have thus been enabled to distinguish that species with certainty from all the other Canceridæ of the London Clay. It is not the *Xanthopsis nodosa* of M'Coy (= *C. Leachii* of your collection), but a species of which you have only one young specimen." These observations, from such a source, would appear to wholly unsettle the conclusion to which I have come on the synonymy of these species; but the fact is that the two figures in M. Desmarest's plate are evidently taken from two very different specimens; and whilst I think the observations of Professor Milne Edwards are clearly applicable to the figure of the under side (see Desmarest, Plate VIII, fig. 6), it is equally clear to me that the other figure in the same plate (fig. 5) is taken from a specimen of *X. nodosa* of M'Coy, which must, therefore, still be retained as a synonym of *X. Leachii*. The former figure I should consider as representing *X. bispinosa*, to which it bears an obvious resemblance in the form of the segments of the abdomen, and this is most probably taken from the specimen referred to by Professor Edwards; but it does not appear necessary further to modify the criticism I have already made on these species.

### ADDITIONS TO THE SYNONYMY.

XANTHOPSIS LEACHII.

*Bronn.* Index Palæont., i, p. 212. *Morris.* Cat. Brit. Foss., 1854, p. 116; Cat. Invert. Mus. Roy. Coll. Surg., 1856, p. 174.

PLAGIOLOPHUS WETHERELLII.

*Parkinson.* Organ Rem., vol. iii, pl. xvii, fig. 1.

DROMILITES LAMARCKII.

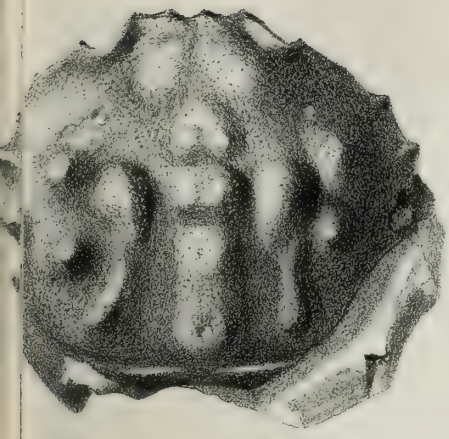
*Parkinson.* Org. Rem., vol. iii, pl. xvii, fig. 7.

BASINOTOPUS LAMARCKII, *Morris.* Cat. Brit. Foss., 1854, p. 101; Cat. Invert. Mus. Roy. Coll. Surg., 1856, p. 176.

## PLATE I.

Fig.

1. Upper side of male *Xanthopsis Leachii* (p. 14). In the collection of Mr. Wetherell. From the tunnel near Chalk Farm.
2. Under surface of the same specimen.
3. *Xanthopsis Leachii;* showing the upper surface of the claws, and the frontal and antennary regions. In the collection of Mr. Bowerbank. From the Isle of Sheppey.
4. Under side of female *Xanthopsis Leachii.* In Mr. Wetherell's collection. From Chalk Farm.
5. Upper surface of *Xanthopsis bispinosa* (p. 15). In Mr. Bowerbank's collection. From Sheppey.
6. Under side of the same.
7. Diagram showing the antennæ and orbits of the genus *Xanthopsis.*
8. Male abdomen of *Xanthopsis.*
9. Female abdomen of ditto.
10. Variety (?) of *Xanthopsis Leachii,* with the anterior two marginal processes obsolete (p. 17). In the collection of Mr. Bowerbank. Sheppey.



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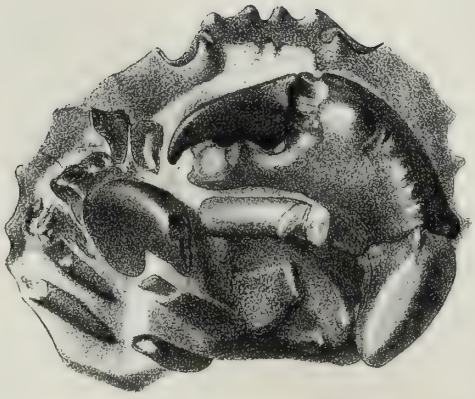

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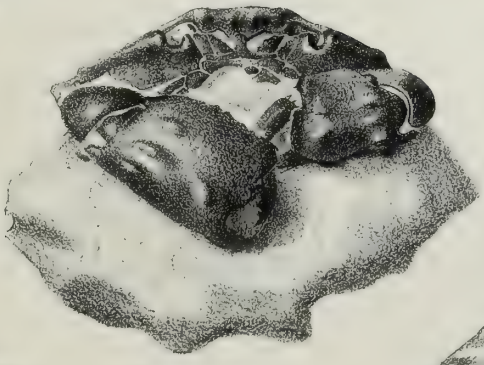

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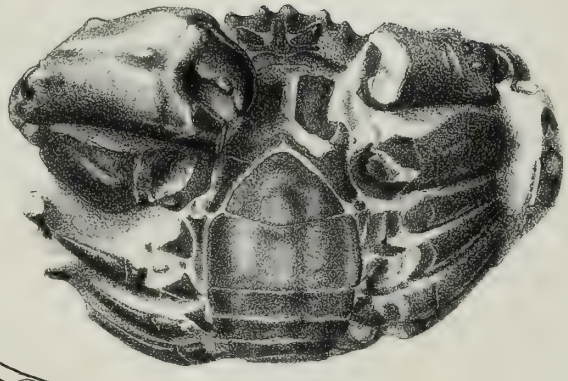

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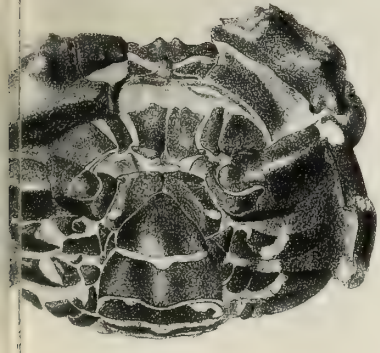

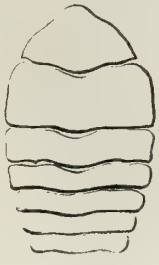

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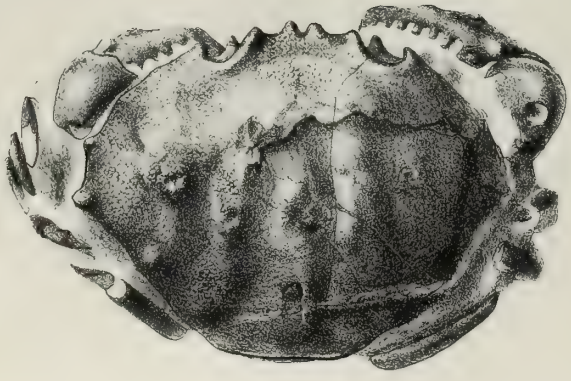

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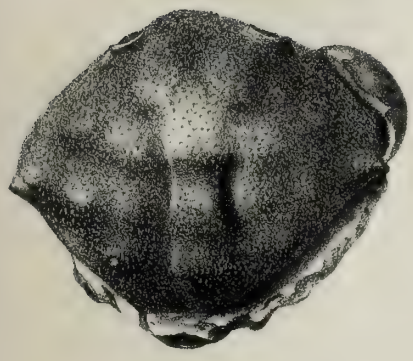
## PLATE II.

Fig.

1. *Xanthopsis unispinosa* (p. 16). In Mr. H. Gould's collection.
2. *Xantholites Bowerbankii* (p. 17). In Mr. Wetherell's collection. Sheppey.
3. *Xantholites Bowerbankii*, showing the lateral processes. In Mr. Bowerbank's collection. Sheppey.
4. *Xantholites Bowerbankii*, showing the claws. In Mr. Bowerbank's collection. Sheppey.
5. Under side of the same, showing the antennæ and external footjaws. From the same collection.
6. Female abdomen of the same.
7. *Plagiolophus Wetherellii* (p. 19). In Mr. Bowerbank's collection. Sheppey.
8. Under side of the same specimen.
9, 10. Younger specimens of the same.
11. Orbits and front of the same.
12. Under side of a small specimen of the same species. In Mr. Bowerbank's collection. Sheppey. Magnified two diameters.
13. Male abdomen of *Plagiolophus Wetherellii*.



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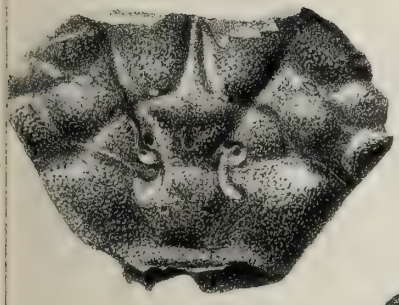

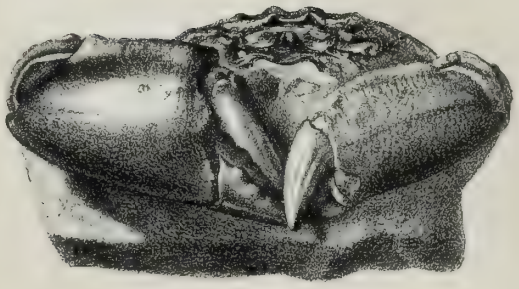

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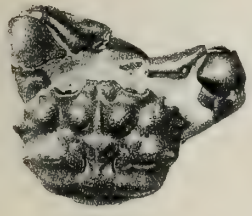

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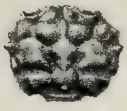

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## PLATE III.

Fig.

1. *Portunites incerta* (p. 21), showing on the left side the posterior leg turned over the back, and resting against the longitudinal elevation on the branchial region. In Mr. Wetherell's collection. Sheppey.
2. *Portunites incerta*, larger specimen, showing the orbits, &c. Mr. Wetherell's collection. Sheppey.
3. Under side of *Portunites incerta*, showing the claws and male abdomen. Mr. Bowerbank's collection. Sheppey.
4, 5. Upper and under side of a small pyritic specimen of *Portunites incerta*. Sheppey.
6. *Œdisoma ambiguum* (p. 22). Mr. Bowerbank's collection. Sheppey.
7. Front view of the same, showing the orbits.
8. *Campylostoma matutiforme* (p. 23). Mr. Wetherell's collection. Sheppey.
9. Large specimen of *Campylostoma matutiforme*, with hypertrophied lateral spine. Mr. Wetherell's collection. Sheppey.
10. Specimen of the same species, showing the inner stalk of the external footjaws. Mr. Bowerbank's collection.

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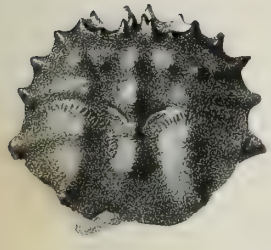

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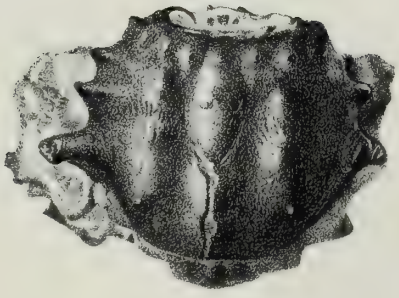

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## PLATE IV.

Fig.

1, 2. *Cyclocorystes pulchellus* (p. 24). Mr. Wetherell's collection. Holloway.

3. *Goniochele angulata* (p. 26). Mr. Wetherell's collection. Sheppey.

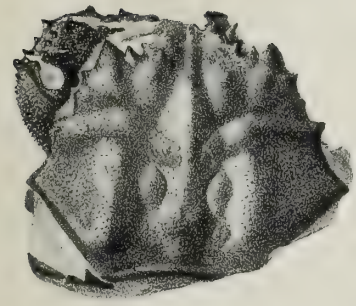
4. Old specimen of *Goniochele angulata*, showing the male abdomen, and the situation of the last two pairs of legs. Mr. Bowerbank's collection. Sheppey.

5. Female *Goniochele angulata*, showing the relative position of the two legs, and the female abdomen. Mr. Wetherell's collection. Sheppey.

6. Under side of fig. 1, showing the claw.

7. Front view of the same specimen, showing the front, the orbits, &c.

8, 9. Male and female abdomen of *Goniochele angulata*.



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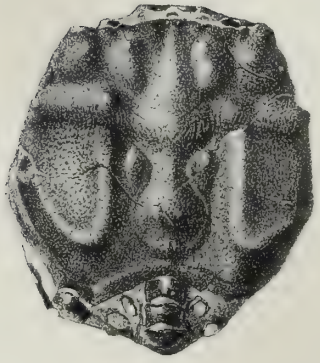

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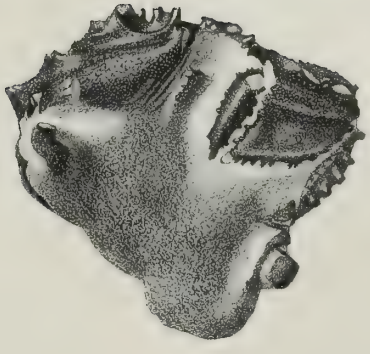

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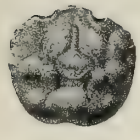

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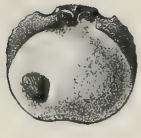

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## PLATE V.

Fig.

1. *Dromilites Lamarckii* (p. 29), male. In Mr. Bowerbank's collection.
2. Female of the same species. In the same collection.
3. The same, a male specimen, showing the length and position of the claws. In the same collection.
4. A younger specimen of the same, showing the marginal spines. In Mr. Wetherell's collection.
5. The hand of the same species. In Mr. Wetherell's collection.
6. Specimen showing the front and orbits.

   The whole of the above are from Sheppey.

8. The male,—and 9, the female abdomen of *Dromilites Lamarckii*.
10. *Mithracia Libinioides* (p. 9). From a specimen in the British Museum.
11. Upper,—and 12, under, side of the same; the latter showing the female abdomen. From a specimen in Mr. Bowerbank's collection, from Sheppey.

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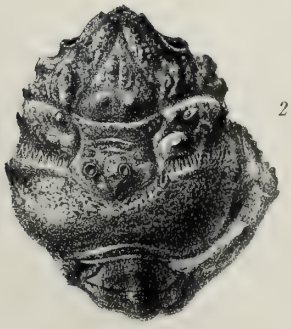
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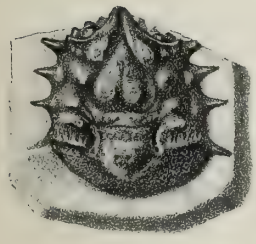
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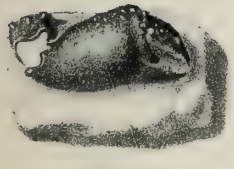
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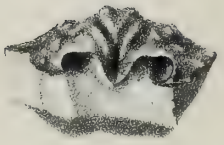
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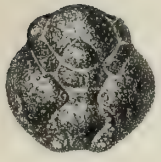
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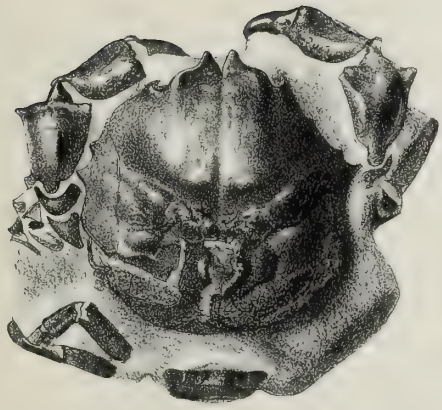
## PLATE VI.

Fig.

1. Upper,—and 2, under, side of male *Dromilites Bucklandi* (p. 31).
3, 4. Similar views of a female specimen.
5. Front view, showing the orbits, and front.
6, 7. Specimens showing the claws.
8, 9, 10. Specimens of different ages, showing the changes in the form and sculpture produced by age.

The whole of the specimens are in Mr. Wetherell's collection, and are from Copenhagen Fields, and the neighbourhood.



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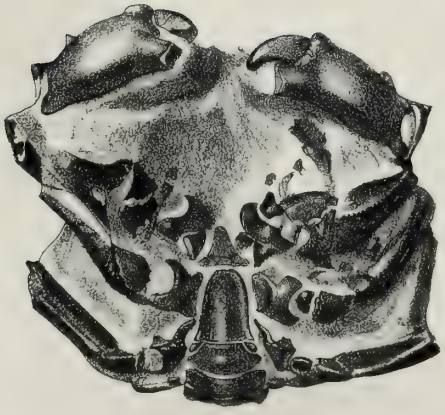

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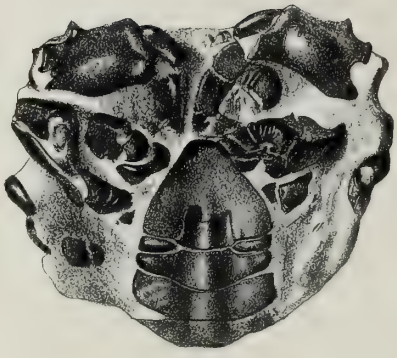

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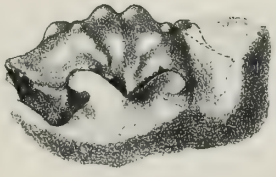

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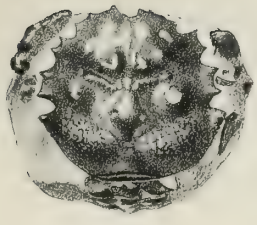

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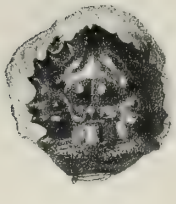

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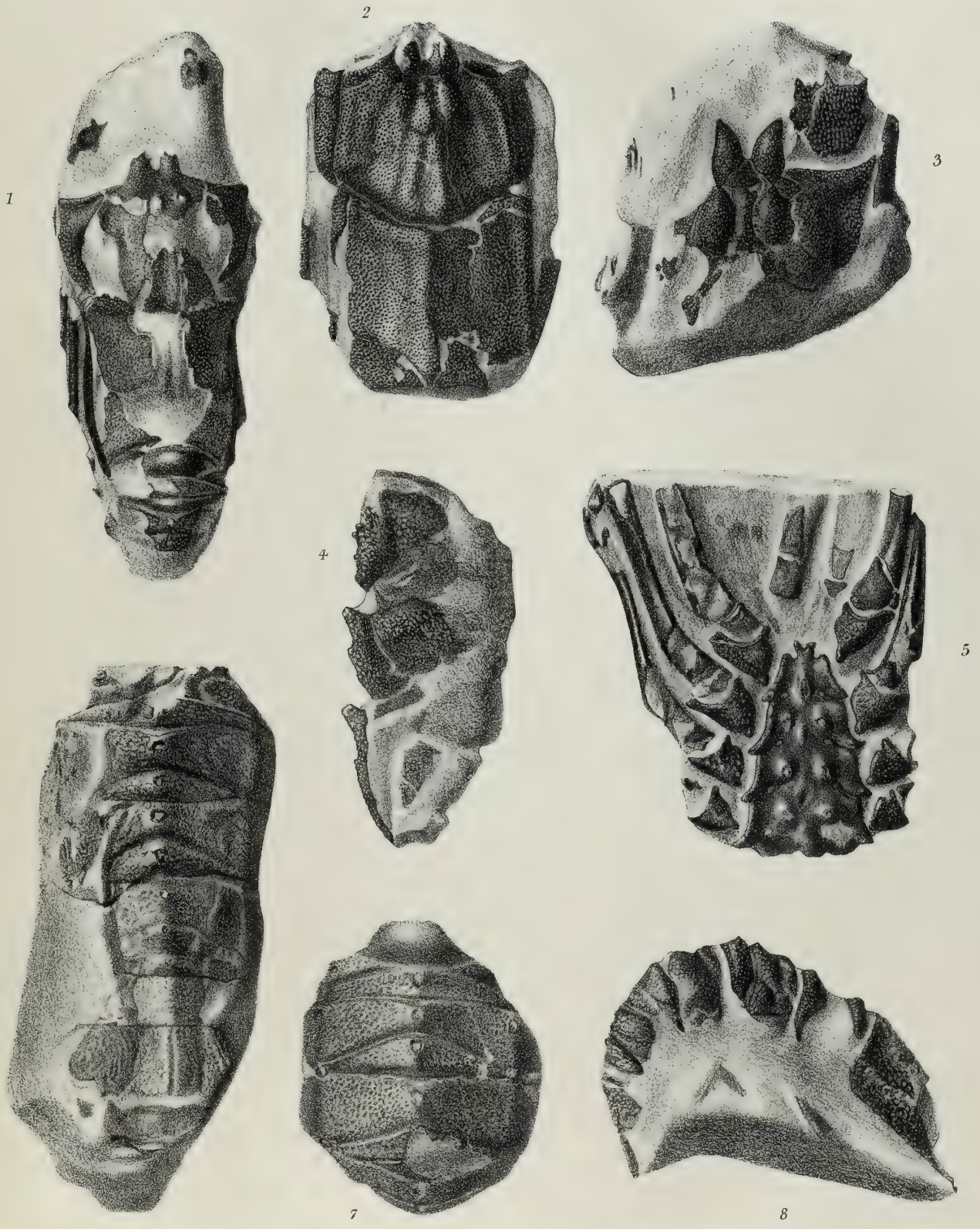
## PLATE VII.

Fig.

1. *Thenops scyllariformis* (p. 33). From a specimen in the British Museum. From Herne Bay.
2. Carapace of a larger individual of the same species. From Chalk Farm. In Mr. Bowerbank's collection.
3. Fragment showing the rostrum, the anterior margin of the carapace on the right side, and the basal joint of the right external antenna. From the same locality, and Mr. Wetherell's collection.
4. The under side of the external antenna, from the same.
5. Thorax and portions of the first four pairs of legs. From a Sheppey specimen in Mr. Bowerbank's collection.
6. View of the abdomen and caudal plates.
7. Three segments of the abdomen.
8. Side view of the same. The last three specimens are from Highgate, and in Mr. Wetherell's collection.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## PLATE VIII.

Fig.

1. *Scyllaridia Koenigii* (p. 35), showing the general form of the carapace and abdomen, and the flat, scylliform, external antennæ. From a specimen in Mr. Bowerbank's collection.
2. Another specimen showing the orbits and eyes. From Mr. Wetherell's collection.
3. Side view of the same. From Mr. Bowerbank's collection.
4. *Hoploparia gammaroides* (p. 38), back view. From a specimen in Mr. Bowerbank's collection.
5. Side view of the same species. Mr. Wetherell's collection.
6. Specimen of the same, showing the caudal plates. From the same collection.

The whole of the specimens of both species are from Sheppey.

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## PLATE IX.

Upper and under sides of a specimen of the claws of *Hoploparia gammaroides*.
From near Copenhagen House. In Mr. Wetherell's collection.

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## PLATE X.

Fig.

1. *Hoploparia Belli* (p. 39). Side view of carapace and abdomen.
2. The same, showing the supra-antennary process, and base of external antennæ.
3. Back of carapace of the same.
4. The caudal plates.
5. Larger claw; and 6, smaller claw of *H. Belli*, being two views of one specimen.
7. The fingers of a specimen of the same species, more than usually curved.
8. Wrist, arm, and part of the hand of the same species.
9. An abnormal form of the carapace of *H. Belli*, or possibly a distinct species (p. 40).

The whole of the above are from Chalk Farm and the immediate neighbourhood, and in Mr. Wetherell's collection.

10. Base of the external antenna, with the scale and the supra-antennary process, of *Nephrops Norvegicus*, to show that in a recent astacoid, these parts are even more armed than in *Hoploparia*.
11. *Trachysoma scabrum* (p. 41). From a unique specimen in the possession of Mr. Wetherell. From the tunnel, near Chalk Farm.

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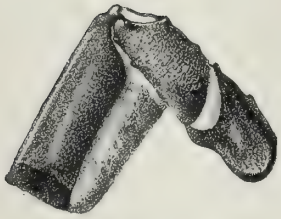

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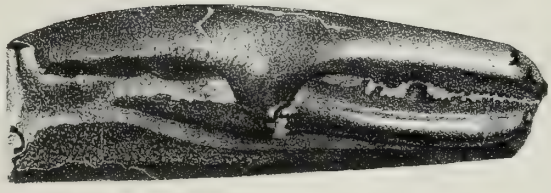

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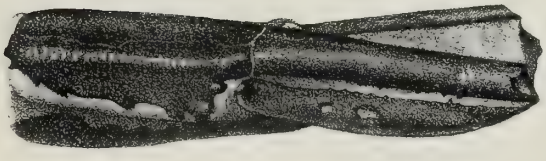

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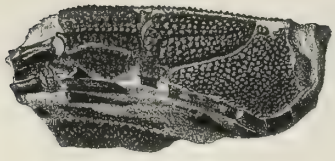

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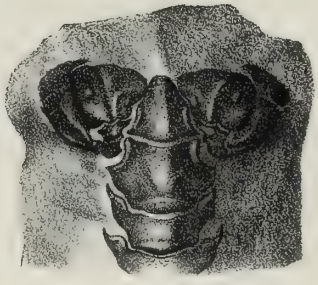

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## PLATE XI.

Fig.

1. *Archæocarabus Bowerbankii* (p. 42). From a specimen in the British Museum.
2. The same, showing the abdomen, and portions of the first four legs. In Mr. Bowerbank's collection.
3. Thorax of the same. In the British Museum.
4, 5. Claws of the same. From Mr. Bowerbank's collection.

The specimens are all from Sheppey.

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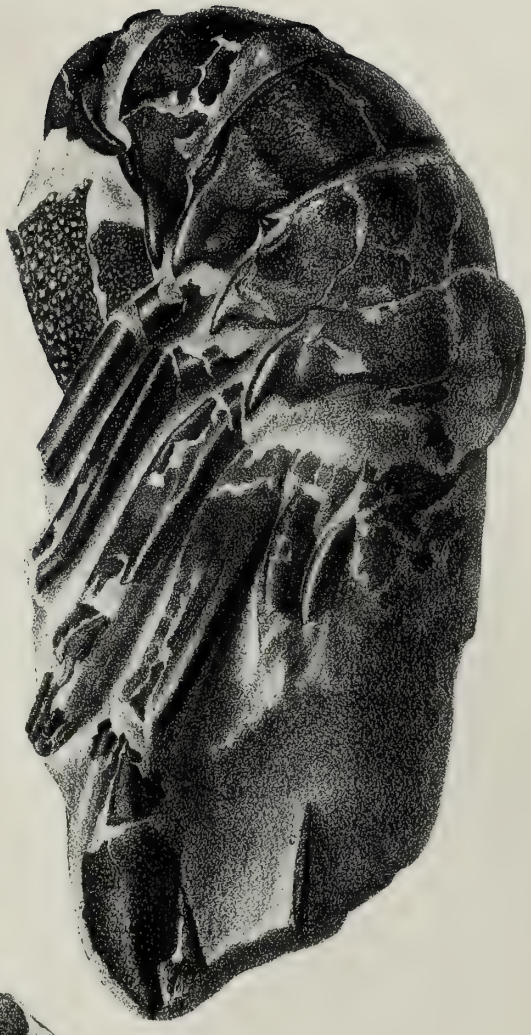

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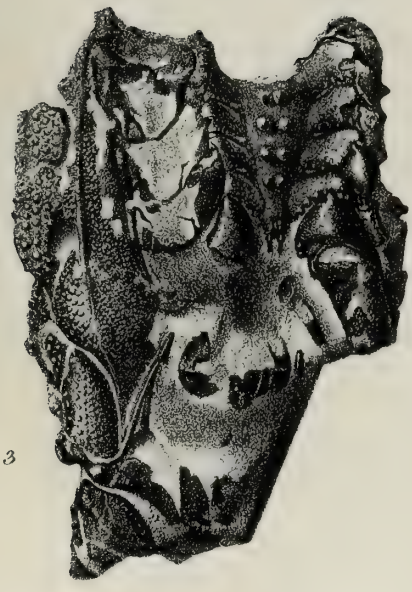

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THE

# PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCLVII.

A MONOGRAPH

OF

# BRITISH

# PERMIAN BRACHIOPODA.

BY

THOMAS DAVIDSON, F.R.S. G.S.,

ETC.

PART IV.

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# PRELIMINARY REMARKS.

The first volume of the present work having been devoted almost entirely to the description and illustration of the Brachiopoda of the Tertiary and Secondary, or Mesozoic series,[1] my second will be appropriated to those of the Permian[2] and Carboniferous periods.

The Brachiopoda of the Permian system of England are few in number, and have been more completely investigated than those of any of the other epochs: they are, with a single exception, described and illustrated in Professor King's valuable Monograph, issued in 1850 by the Palæontographical Society; this work being at the same time the largest and most complete that has hitherto appeared on British Permian fossils.

It may, therefore, be very naturally inquired why I should have taken upon myself to write on a subject apparently so completely investigated; my excuse must be based upon the necessity I found myself under to combine my series of Monographs by a few pages on the Permians, and especially so as the study of several publications prior and subsequent to 1850, as well as of a vast amount of new and very perfect material in the possession of Messrs. Howse and Kirkby, has made it desirable to propose a few small alterations to the works hitherto published, as well as to offer some additional details and illustrations, which will not, I trust, be considered entirely superfluous.

[1] For hitherto no species belonging to the class have been discovered in any of the Triassic beds of Great Britain, which include the *variegated marls, Keuper* and *Bunter Sandstein.*

[2] It will not be necessary to enlarge upon the geology of the group, as this has been done already by different authors, and of which a full account will be found in one of the Society's volumes; but I will mention the subdivision of the beds, as latterly proposed by Mr. Howse in his valuable paper, published in the 'Annals of Nat. History' for January, 1857. In the descending order we find—

| | | |
|---|---|---|
| 1. Upper yellow sandstone | Upper | Magnesian limestone. |
| 2. Conglobated or Botryoidal limestone | | |
| 3. Concretionary or cellular limestone | Middle | |
| 4. Shell limestone (Zechstein dolomit of the Germans | | |
| 5. Magnesian conglomerate | Lower | |
| 6. Compact limestone | | |
| 7. Marl slate. | | |

The Brachiopoda are found in the *marl slate, compact limestone, conglomerate,* and *shell limestone* only.

The following pages will therefore require to be considered more as a supplement to the important labours of Professor King and Mr. Howse than that of a separate Monograph, as to those authors the chief credit is due of having worked out our English Permian species. My efforts have been especially directed to the minute illustration and study of every internal character which the perfect material at my disposal has enabled me to develop. I have also avoided reproducing long lists of synonyms, references, and certain other details which will be found in the works of the two gentlemen already named.[1]

In the preparation of the following pages, I have been most kindly assisted by several

[1] Professor King has published a long list of all the works relating to Permian fossils, from the year 1710 to 1850; to which I will now add a few others, so as to carry the catalogue down to the present time.

It will also be desirable to mention that both Professor King and Mr. Howse had for many years prior to 1848 been busily engaged collecting and studying the Permian fossils of the counties of Durham and Northumberland. In 1844 Professor King supplied M. De Verneuil with a manuscript list of the British species then known to him, which comprised the following Brachiopoda ('Bulletin de la Société Geologique de France,' vol. i, 2d series, p. 500, 3d of June, 1844): *Terebratula elongata*, *T. sufflata*, *T. pectinifera*, *T. Schlotheimi* (to this last M. De Verneuil added that Mr. King had proposed for it and *T. superstes* a new genus, named *Camarophoria*), *Spirifer undulatus*, *S. multiplicata*, *S. cristata*, *Productus horridus*, *Strophalosia Morrisiana*, *Stroph. spinifera*, and *Lingula mytiloides*. These names were also subsequently introduced into the first and second volumes of the 'Geology of Russia,' in 1845; and in 1846 Professor King's excellent memoir appeared, 'Remarks on certain Genera belonging to the Palliobranchia,' wherein, besides much important matter relating to the Brachiopoda in general, the genera *Camarophoria* and *Strophalosia* are for the first time explained. In 1847 Professor King prepared a Catalogue of the organic remains of the Permian rocks of Northumberland and Durham, which he presented to the Tyneside Naturalists' Club for publication, but which having been withdrawn by its author, another Catalogue was prepared by Mr. Howse at the request of the Club. Both were, however, printed during the month of August, 1848, and a delicate question arose as to the exact day of publication; but from evidence communicated by the publishers, it would appear that the one written by Mr. Howse was issued on the 17th, while that of Professor King appeared on the 19th of the same month.

They are both excellent and valuable productions, and prove the great knowledge possessed by their respective authors on the local Permian species, as well as their ability to write upon the subject; but in justice to Dr. Geinitz, I feel bound to observe (as has already been stated by Mr. Howse) that the 'Die Versteinerungen des deutschen Zechsteingebirges,' having appeared in April, 1848, does, as a matter of course, hold priority over both the catalogues of the above-named gentlemen for any new species it may contain.

In 1848 and 1854, a Russian work of considerable merit, but unfortunately little known, was published at Dorpat, 'Reise nach dem Nordosten des Europäischen Russlands durch die Tundren der Samojeden,' by Alexander Gustav Schrenk. In the first volume are mentioned several Permian fossils, which were well described and illustrated by Count Alex. von Keyserling, in pp. 81—114 of the second volume. *Productus hemisphæricum*, Kutorga, *Prod. Cancrini*, Vern. and Keyserling, *Strophalosia tholus*, Keys., *Spirifer Schrenkii*, Keys., *Tereb. Royssiana*, Keys., and *Terebratula concentrica*? Buch, var. *Permiensis*, and *Terebratula Geinitziana*, Vern., are the species of Brachiopoda discovered in 1837, by Dr. Schrenk, in that northern portion of the Russian empire.

We must also refer to Professor De Koninck's 'Nouvelle notice sur les Fossiles de Spitzberg,' published in the sixteenth volume of the Académie Royale de Belgique, in which the author has described and figured

zealous friends, to whom it is a most pleasing duty to tender my grateful thanks. To Professor King, of Queen's College, Galway; to Mr. R. Howse, of South Shields; and to Mr. Kirkby, of Bishopwearwouth, I am equally and especially indebted for much valuable information, the liberal loan of the beautiful specimens of their collections, as well as for the indefatigable exertions they made in procuring the material required for the complete illustration of several of the species figured in the accompanying plates.

To Mr. G. Tate, of Alnwick; Mr. Hancock, of Newcastle; Mr. Binney, of Manchester; and Dr. Carpenter, of London, I am greatly obliged for much useful information. To Sir Roderick Murchison and Professor Huxley, for the use of Mr. Howse's original specimens, preserved in the Museum of the Geological Survey; and to Mr. S. P. Woodward, for some in the British Museum.

To Baron Schauroth, of Coburg, M. Eisel, jun., and to Professor Geinitz, I am indebted for valuable information, as well as the kind gift of a numerous series of German specimens, which have enabled me to compare our English forms with the equivalents found on the Continent, the shells from the Zechstein Dolomit of Pössnech, &c., being identical with those so abundantly distributed in the magnesian shell limestone of Humbleton and other of our British localities.

I must also express my warmest acknowledgments to Count Keyserling, of Raikull, near Reval, for the valuable information and most zealous endeavours he has made to procure for me several important Russian specimens, required for the perfect elucidation and identification of some of our English types; as well as to Dr. A. G. Schrenk and

*Prod. horridus, P. Cancrini, P. Leplayi, P. Robertianus, Spirif. alatus,* and *Sp. cristatus* from that distant region. Professor King had already noticed his first paper on the subject published in 1846.

In 1853, 'Ein Beitrag zur Fauna deutschen Zechsteingebirges,' by Dr. Baron Karl v. Schauroth, was published.

In 1854, 'Ein Beitrag zur Palæontologie des deutschen Zechsteingebirges,' by the same author, whose excellent publications on German Permian fossils has added very considerably to our knowledge on the subject.

In 1855, 'On the Permian Beds of the North-west of England,' by E. W. Binney; but no Brachiopoda have been discovered in the Permians of this part of England nor in any of the Irish similar beds.

In 1856, 'On the Occurrence of Permian Magnesian Limestone at Tullyconnel, near Artrea, in the County of Tyrone,' by Professor W. King.

In 1856, 'Ein neuer Beitrag zur Palæontologie des Zechsteingebirges,' by Baron v. Schauroth.

'Notes on Permian Fossil Palliobranchiata,' by Professor King.

In 1857, 'Notes on the Permian System of the Counties of Durham and Northumberland,' by R. Howse, Esq.

'Notes sur les genres *Athyris* (= *Spirigera*), *Camarophoria, Orthesina,* et *Strophalosia,*' par Mr. Thomas Davidson. ('Bulletin de la Société Linnéenne de Normandie,' vol. ii, pl. i and ii).

Besides these, several other memoirs on Permian rocks and fossils have been published by Dr. Geinitz, Mr. Coquand, and by the Geological Survey of Missouri; but which, not containing any matter in direct reference to the Brachiopoda, need not be at present more fully reverted to.

Professor Dr. C. Schmidt, of Dorpat, for the gift of some interesting specimens; also to General Von Helmersen, of St. Petersburgh; M. De Koninck, of Liege; and M. De Verneuil, of Paris, who have all facilitated and contributed to my researches among the species which will form the subject of the following pages.

The British localities, and stratifigraphical position here given, are those already published or contributed by Mr. Howse and Professor King.

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TABLE OF THE BRACHIOPODA HITHERTO DISCOVERED IN THE BRITISH PERMIAN BEDS.

PART IV.

| No. | Genus and Species. | Author. | Date. | Reference to my Plates and Figures. | Marl Slate. | Compact Limestone. | Magnesian Conglomerate. | Shell Limestone. | Botryoidal Limestone. | Upper Yellow Limestone. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Terebratula elongata | Schlotheim | 1816 | pl. i, f. 5—7, 12—14, 18—22 | .. | * | * | * | | |
| | *var.* sufflata | Schlotheim | 1816 | pl. i, f. 8—11, 15—17 | | | | | | |
| 2 | Spirifera alata | Schlotheim | 1813 | pl. i, f. 23—36 | .. | * | * | * | | |
| 3 | ? clannyana | King | 1848 | pl. i, f. 47—49 | .. | * | .. | * | | |
| 4 | Spiriferina cristata | Schlotheim | 1816 | pl. i, f. 37—40, 45, 46; pl. ii, f. 43—45 | .. | .. | .. | * | | |
| 5 | multiplicata | J. de C. Sow. | 1829 | pl. i, f. 41—44 | .. | .. | .. | * | | |
| 6 | Athyris pectinifera | J. de C. Sow. | 1840 | pl. i, f. 50—56; pl. ii, f. 1—5 | .. | .. | * | * | | |
| 7 | Camarophoria Schlotheimi | Von Buch | 1834 | pl. ii, f. 16—27 | .. | .. | * | * | | |
| 8 | globulina | Phillips | 1834 | pl. ii, f. 28—31 | .. | .. | * | * | | |
| 9 | Humbletonensis = *multiplicata*, King | Howse | 1848 | pl. ii, f. 9—18 | .. | .. | * | * | | |
| 10 | Streptorhynchus pelargonatus | Schlotheim | 1816 | pl. ii, f. 23—42 | .. | .. | .. | * | | |
| 11 | Productus horridus | Sowerby | 1822 | pl. iv, f. 13—26 | .. | * | * | * | | |
| 12 | latirostratus = *umbonellatus*, King | Howse | 1848 | pl. iv, f. 1—12 | .. | .. | .. | * | | |
| 13 | Strophalosia Goldfusii | Münster | 1839 | pl. iii, f. 16—18 | .. | * | .. | * | | |
| | *var. Lewisiana* | De Koninck | 1846 | pl. iii, f. 19—22 | .. | * | .. | * | | |
| 14 | lamellosa | Geinitz | 1848 | pl. iii, f. 33 | .. | * | .. | * | | |
| | *var. Morrisiana* | King | 1848 | pl. iii, f. 24—31 | .. | * | .. | * | | |
| | *var. Humbletonensis* | King | 1850 | pl. iii, f. 34—41 | .. | * | .. | * | | |
| 15 | Crania Kirkbyii | Davidson | 1857 | See woodcut | .. | .. | .. | * | | |
| 16 | Discina Koninckii | Geinitz | 1848 | pl. iv, f. 27—29 | * | * | .. | * | | |
| 17 | Lingula Credneri | Geinitz | 1848 | pl. iv, f. 30, 31 | * | * | | | | |

# MONOGRAPH

OF

# BRITISH PERMIAN BRACHIOPODA.

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*Family*—TEREBRATULIDÆ.

*Genus*—TEREBRATULA. (*Vide* General Introduction, Vol. I, p. 61, 1853.)

SEMINULA, M'Coy, 1844, 1855. EPITHYRIS, King, 1855.

Professors M'Coy and King are of opinion that the Palæozoic TEREBRATULÆ, *T. elongata, T. sacculus, T. hastata, T. vesicularis*, and *T. ficus*, &c., should be generically separated from TEREBRATULA proper, such as *T. vitrea, T. carnea, T. biplicata*, &c., on account of certain peculiarities to be hereafter described, and have respectively proposed *Seminula* and *Epithyris* as generic denominations for their reception.

The first mention of *Seminula* by M'Coy will be found at p. 158 of the 'Synopsis of the Carboniferous Fossils of Ireland,' 1844; but the characters therein are so vaguely expressed, that I did not consider it necessary to draw attention to the fact while writing my General Introduction. However, as Professor M'Coy has again introduced his genus,[1] with different characters and types from those made use of in 1844, it will be necessary to revert to the subject with some detail.

"Genus *Seminula*, M'Coy, 1844.—*Gen. Char.* Shell small, sub-pentagonal; smooth, or slightly plaited at the margin; beak of the dorsal valve small, with a minute perforation; no deltidium. The species of this genus are all small, nearly smooth shells; the margin frequently indented, but no distinct plaits on the surface; the outline is more or less pentagonal; the beak has a very minute foramen, for the passage of the muscle of attachment, but there is no deltidium separating the foramen from the hinge. This genus is peculiar to the Palæozoic rocks. Examples: *S. pentahedra*, Phillips, sp.; *S. pisum*, M'Coy; *S. rhomboidea*, Phillips."

It may, however, be observed, that none of the shells here enumerated present the

[1] 'British Palæozoic Fossils,' p. 408, 1855.

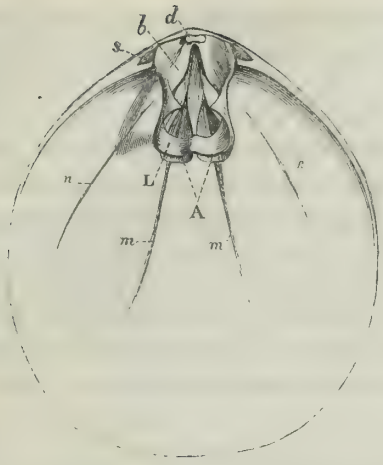
characters of any of the Terebratulidæ; for *T. pentahedra* appears to possess spirals, and is consequently an Athyris; while *S. pisum*, M'Coy = *T. seminula*,[1] Phillips, and *S. rhomboidea*, Phillips, are Rhynchonellæ.

In 1855, Professor M'Coy describes his genus thus: "*Gen. Char.* Ovate; a large oval perforation on the beak of the receiving valve (ventral or dental one), separated from the hinge-line by a portion of the valve, but apparently without deltidium; dental lamellæ strongly developed in beak of receiving valve, slightly diverging entering valve (dorsal, Owen), with a faint trace of mesial septum, and two cardinal teeth, from whence a small loop, with a very short recurved portion, arises; substance of the shell punctuated, usually without plaits. . . . . Lately, Professor King has given much excellent information on the genus, in his volume on the 'Permian Fossils of England,' under the name of *Epithyris* of Phillips, and pointed out the valuable and easily ascertained character of the strong dental lamellæ in the beak, bordering the foramen. From the observations in the middle of p. 54 of Phillips's 'Palæozoic Fossils,' it is obvious, however, that *Epithyris* was intended for the Oolitic *Terebratula*, congeneric with *T. maxillata*, having distinct deltidium, &c. The dental lamellæ leave slits in the beak of the casts, one on each side of the foramen, which are very characteristic of the genus, and in some states of exfoliation of the shell are likely to be confounded with the edges of the deltidium; indeed, the appearance thus produced in many specimens is so puzzling, that I prefer leaving the existence or non-existence of a deltidium an open question, the genus being well distinguished meanwhile from the more recent *Terebratulæ* by the rostrum being separate from the extension of the dental lamellæ, &c. This generic type seems confined to the Palæozoic rocks. Examples: *T. elongata*, Schloth.; *T. ficus*, M'Coy; *T. hastata*, Sow.; *T. juvenis*, Sow.; *T. sacculus*, Martin; *T. seminula*, Phillips;[2] *T. sufflata*, Schloth.; *T. virgoides*, M'Coy."

All these shells belong to the same generic type of *Terebratulidæ;* but the question to be determined is, whether they should be separated from Llhwyd's genus, and if so, whether Professor M'Coy's denomination should be the one selected. For the sake of comparison, I have tabulated the differences observable between *Terebratula*, Llhwyd, and those shells which are considered by M'Coy and King to constitute a separate genus.

[1] Professor M'Coy seems to have entirely misunderstood Professor Phillips's *T. seminula*, as will be found explained in my Monograph of Carboniferous species.

[2] The shell described as *T. seminula* (Phillips) by Professor M'Coy in 1855 is *T. vesicularis*, De Koninck, and not *T. seminula* of Phillips, nor the one made use of in the 'Synopsis.'




TEREBRATULA, Llhwyd.

*Ter. vitrea* (dorsal valve).

*d.* Cardinal process. *b.* Hinge-plate to loop. *s.* Sockets. *A.* Quadruple impression of the adductor. *m.* Inner groove. *n.* Outer groove.

*Ventral valve.*

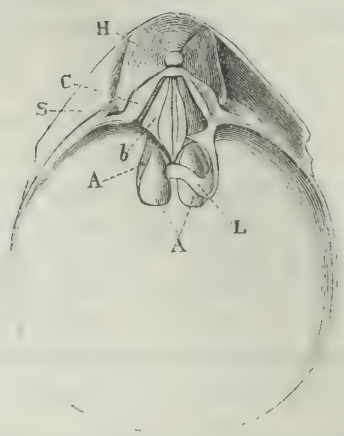
1. No prominent rostral plates, only a simple thickening of the shell, at the dental projections, which leave no slits in the beak of internal casts.

2. In the interior two diverging grooves (*m*) extend from the extremity of the beak to a little more than half the length of the valve; there are also two other smaller lateral ones (*n*); so that in casts four diverging ridges may at times be perceived placed at nearly equal distances.

3. The muscular impressions are close together, and occupy a small space at a short distance from the extremity of the beak; they are more or less indented, according to the thickness of the shell, and consist of a small, central, oval scar left by the adductor, on either side of which are placed the larger cardinal ones, and outside of these again may be seen the pedicle muscular impressions, which vary in dimensions in different species according to the size of the pedicle and foramen.

*Dorsal valve.*

4. In the interior a small cardinal process or boss projects from under the extremity of the umbonal beak (*d*); the hinge-plate is divided, and consists of two rather wide and somewhat oblique shelly plates (*b*); from the prolonged extremities of these depart the




SEMINULA, M'Coy = *Epithyris*, King.

*T. elongata*, Schlotheim (interior of dorsal valve with part of the ventral one).

*H.* Rostral or dental plates of ventral valve. *S.* Sockets of dorsal valve. *C. b.* Hinge plates. *L.* Loops. *A.* Adductor impressions.

*Ventral valve.*

1. Well-defined dental or rostral plates, leaving slits in the beak of casts.

2. In the interior there exists a mesial longitudinal ridge, extending from the extremity of the beak to about two thirds of the length of the valve, and two shorter sub-parallel ones, situated at a small distance from the central one.

In casts these produce slight grooves, the central one being particularly evident.

3. The muscular impressions appear to be similar to those of *Terebratula* proper, and have left but slight impressions in the interior of the shell or on the casts of the specimens that have come under my notice.

*Dorsal valve.*

4. The cardinal process seems to be but slightly protruded; the hinge-plates varying somewhat in detail in different species, and even individuals. There exists first a testaceous ridge or plate (*C*), which forms at the same time the inner socket walls, and two

short longitudinal riband-shaped lamellæ, which are soon united by a transversal lamella, which is more or less bent upwards in the middle (*L*). This simply attached loop is confined to the posterior portion of the shell, and does not exceed much more than one third of the length of the valve. There are no sloping hinge-plates attached to the bottom of the valve, as in *T. elongata* and kindred forms, nor lozenge-shaped elevation. The quadruple impressions of the adductor muscle (*A*) being impressed on the bottom of the shell, exactly under the short simple loop, the diverging grooves (*m*) passing uninterruptedly through them.

other oblique and diverging ones (*b*) attached to those already described, and fixed to the bottom of the shell (Pl. I, fig. 19). From these proceed the longitudinal branches of a short simple loop (*A*), similar in character to that of *Terebratula* proper. A minute mesial ridge extends from under the cardinal process; these plates, with their central interspace and mesial ridge, form a lozenge-shaped elevation (Pl. I, fig. 18, also woodcut). On either side of this process, and extending further down, are seen the quadruple impressions left by the adductor (*A*), as dispayed in the accompanying cut.

From the above it will be perceived that the differences between *Terebratula* proper and *Epithyris*, as typified by Professor King in 1850, are chiefly confined to the presence of prominent dental or rostral plates in the one, and almost total absence in the other, as well as differences in certain details connected with the hinge-plate. On the other hand, the exterior characters are similar, the deltidium being more or less concealed in certain individuals than in others, from the greater or lesser approximation of the foramen to the umbonal beak.[1] This is also the case in many species of true *Terebratula*. In the interior the loop is the same, short, and simply attached, the longitudinal branches being united by a transversal band, more or less bent upwards in the middle.[2] The muscular impressions appear also similar, as well as the intimate shell-structure.

It will therefore be for palæontologists to determine whether the differences observable in the rostral cavity of the beak and hinge-plate of these few Palæozoic *Terebratula* should be considered of sufficient value to counterbalance the great resemblance they present with *Terebratula* proper in their more important dispositions and characters.

TEREBRATULA ELONGATA, *Schloth.*, sp. Plate I, figs. 5—22; and Plate II, fig. 2.

A difference in opinion has been expressed by some British and foreign palæontologists relative to the respective specific claims of *Ter. elongata* and *T. sufflata* of Schlotheim. These shells are so extremely variable in their shape, that Professor King could not help

[1] I am rather surprised that Professor M'Coy should have doubted the presence of a deltidium in *T. hastata*, *T. elongata*, and other similar shells, for it may be seen in many individuals, and more especially in young shells.

[2] Professor King states that "*Waldheimia* is most intimately related to *Epithyris*;" that "in *Waldheimia* the loop is elliptical, deeply recurved, and projecting about two thirds of the length of the shell; but that in *Epithyris* it is semi-elliptical, moderately recurved, and projecting about one third of the length of the shell." I do not perceive any important differences in its loop and that of *Terebratula*; moreover, Professor King admits that his illustration, pl. vi, fig. 45, was not quite correct.

observing, that Schlotheim considered some of their varieties as species,[1] and that he himself has no decided objection to that view, but feels utterly unable to separate one from another, as they merge so imperceptibly into each other. Professor King admits but two out of Schlotheim's several species, viz., *T. elongata* and *T. sufflata;* this view has also been reciprocated by Professor M'Coy.[2] On the other hand, Dr. Geinitz,[3] Baron Schauroth,[4] Mr. Howse,[5] and a few others, consider that there exists no valid grounds for even separating specifically *T. sufflata* from *T. elongata,* and either entirely amalgamate the two under the single denomination of the last-named shell, or consider *sufflata* in the light of a named variety.

Having had the opportunity of examining a very numerous series of both, I experienced the same difficulties in the attempt to separate *T. elongata* and *sufflata.* No doubt, if certain typical, or what might be considered typical shapes of both are selected, we might perceive certain peculiarities in each, and be tempted, perchance, to create more than one species; but these variations seem to exist only in certain individuals, while every intermediate form would be found in the same bed, and even quarry, to connect these different extremes. Such being the case, I have preferred to follow in the path of those authors who, while admitting but one species, have retained *sufflata* for the variety.

TEREBRATULA ELONGATA, *var.* GENUINA. Plate I, figs. 5—7, 12—14, and 18—22. (King's Mon., pl. vi, figs. 30—45.)

TEREBRATULITES ELONGATUS et COMPLANATUS, *Schlotheim.* Akad. Münch., vol. vi, p. 27, pl. vii, figs. 7—14, 1816.

When full grown and well shaped, it is more or less elongated, widest near the middle, with almost equally deep, convex valves. The beak is more or less attenuated and incurved; the foramen rather small and circular, lying close to the umbone of the dorsal valve, so that the deltidium is but rarely exposed. The larger or ventral valve is moderately convex, presenting in profile a regularly arched curve from the extremity of the beak to the front, with a wide and gradually depressed or shallow sinus, commencing towards the middle of the valve, and extending to the front in almost all well-shaped examples; it produces in the frontal margin a convex and elevated curve, varying in degree according to age and individuals.

[1] 'Monograph of English Permian Fossils,' p. 148, 1850.
[2] 'British Palæozoic Fossils,' pp. 409, 412, 1855.
[3] 'Die Versteinerungen,' p. 11, pl. iv, fig. 27, April, 1848.
[4] 'Ein neuer Beitrag zur Palæontologie des deutschen Zechsteingebirges,' p. 213, 1856.
[5] 'Annals and Mag. of Nat. Hist.,' vol. xix, 2d series, p. 52, 1857.

The sinus is also sometimes narrow and more suddenly depressed (Pl. I, fig. 5; and pl. xlii *a* of King's Monograph), and hardly perceptible in certain middle-aged and young shells.

The dorsal valve is more or less regularly convex, with a mesial longitudinal elevation extending from the extremity of the umbonal beak to the front, from which the lateral portions of the valve slope more or less rapidly to the margins. External surface smooth;[1] shell-structure minutely perforated.

The internal details having been already described under the genus, need not be repeated. The dimensions attained by this species are very variable.

The largest two British specimens I have seen measured—

Length $17\frac{1}{2}$, width 15, depth 8 lines.

„ 19, „ 13 lines.

*a. Var.* SUFFLATA. Plate I, figs. 8, 9, 10, 11, 15, 16, 17, and 21; Plate II, fig. 2. (King's Monog., pl. vii, figs. 1—9.)

TEREBRATULITES SUFFLATA, *Schlotheim*. Akad. Münch., vol. vi, pl. vii, figs. 10, 11, 1816.

This shell is smaller, relatively wider, and more inflated than the var. *elongata;* ovate; margins obtuse, and sometimes slightly emarginate in front. The *ventral valve* is either regularly convex (Pl. I, fig. 11), or presents a narrow mesial sinus, which is more or less excavated (Pl. I, figs. 16, 17; and Pl. II, fig. 2) in different specimens, so that the frontal line varies considerably in the convexity of its curve. The *dorsal valve* is more or less regularly inflated; surface smooth. Interior exactly similar to that of *elongata*. In dimensions this variety does not appear to greatly exceed—

Length 7, width 6, depth 5 lines.

Professors King and M'Coy are of opinion that this shell should be specifically separated from *T. elongata*, as has been already observed. They state that it is smaller and more tumid, with a greater gibbosity, and with more obtuse angles; the umbone more gibbous and prominent (?), a small definite lobe in the front margin, and corresponding long, narrow mesial sulcus in the ventral valve; the posterior part of the shell not so tapering, and the sides of the beak more obtusely rounded and less angulated.

[1] In his 'Notes on Permian Palliobranchiata,' published in the 'Annals of Natural History' for March and April, 1856, Professor King observes that "specimens occasionally occurring at Glücksbrunn show *T. elongata* to have been a prettily coloured species; in one example several dark bands interradiating with others of a lighter colour almost continuously from the umbone to the margin, and increasing in width in their forward progress; in another, the dark bands reduced to dark lines are only developed near the margin."

It is not very difficult to find a number of examples presenting all these differences; but again it would be as easy to procure others which, from their intermediate character, leave one in the greatest doubt as to which of the two they should be referred; thus a vast number of *sufflata* present not a trace of sinus or sulcus in the ventral valve, both being regularly and equally inflated. Some also vary considerably in their depth, and with smaller proportions, resemble the two large adult examples of *T. elongata*, illustrated in our plate (Pl. I, figs. 5 and 18); and I can compare them to nothing better than to the differences we would perceive between a tall, thin, and a short, thick, stumpy man, the first representing *T. elongata*, the second *T. sufflata*.

Professor King is of opinion that *T. sufflata* closely resembles the Carboniferous *T. sacculus* of Martin; and, having kindly forwarded for my examination a specimen of both, they appeared to me undistinguishable; but having compared a numerous series of the Carboniferous and Permian varieties of *T. elongata*, *sufflata*, and *sacculus*, I could perceive in none of the Permian specimens the depression which commonly exists near the front of the dorsal valve of most individuals of the Carboniferous species; there remains but little doubt as to the intimate resemblance existing between certain examples of Martin's and Schlotheim's shell. *T. elongata* is certainly specifically distinct both from *T. hastata* and *sacculus;* and if we are to consider *T. sufflata* as a var. of *elongata*, then the individual similarity presented between some young examples of *sacculus* and *sufflata* cannot be considered of paramount importance, as the general facies of the species would be very different; but if, on the contrary, *T. sufflata* is to be considered as specifically different from *T. elongata*, then it would become a delicate question to determine whether *sufflata* is in reality more than a variety or race of Martin's *T. sacculus*.[1]

*Loc., &c.* Both *T. elongata* and its var. *sufflata* are common to the same beds and localities. It is also one of our commonest English Permian species in the shell limestone of Tunstall-hill, Humbleton, Ryhope-Fieldhouse farm, Hilton Castle, Clack's Heugh, Dalton-le-dale, &c. It has also been found in the magnesian conglomerate of Tynemouth. On the Continent it is common to several localities—Corbusen, Pössneck, &c., in Germany; at Nikefur, Orenbourg, Ilschalki, &c., in Russia.

[1] Professor King observes, while describing *Ter. sufflata*, that he has elsewhere stated that "this species appears to be identical with a shell found in the mountain limestone of Bolland, probably hitherto considered a var. of *T. sacculus*, a distinct, although closely allied species ('Monograph,' p. 150). M'Coy supposes that the shell here referred to is identical with *T. virgoides*, but this is not the case. The Bolland specimen, noticed under the last head as resembling *T. elongata*, has more affinity to M'Coy's species. I have been led to re-examine the shell found in the neighbourhood of Bolland, and I cannot but say that it agrees most remarkably with some specimens of the Permian species, particularly the testiferous one represented under fig. 7, pl. vii, of my 'Monograph.' On the other hand, there are specimens figured on the same plate closely approximating to true forms of *T. sacculus* in its mesial depression and emarginate front. The only difference I perceive between the Bolland shell alluded to and the Permian fossil quoted is, that on the former there are faint traces of longitudinal lines on the anterior half of the valves. I perceive nothing of the kind on any of the Permian forms, nor do I recognise any on normal specimens of *T. sacculus:*

## *Family*—SPIRIFERIDÆ.

In the French edition of my General Introduction, published in vol. x of the 'Transactions of the Linnean Society of Normandy,' I have provisionally divided the family SPIRIFERIDÆ into three principal genera—SPIRIFERA, Sow., ATHYRIS, M'Coy = *Spirigera*, D'Orb., ATRYPA, Dalman; and into six sub-genera—*Cyrtia*, Dalman, *Spiriferina*, D'Orb., *Suessia*, E. Deslong., *Retzia*, King, *Merista*, Suess, and *Uncites*, Defr. But before a genus or sub-genus can occupy a definite and permanent position in science, it is necessary to be acquainted with all its characters, both internal and external, and to have appreciated these characters so as to be able to compare them to those of other genera in the same family.

Some short time since only have all the internal arrangements of the three above-named genera been completely ascertained, that of *Athyris* in particular having resisted for many years the most persevering researches.[1] The differences presented by these genera are most satisfactory; they represent three *well-defined types*, around which certain modifications of comparatively smaller value naturally converge. Of the six sub-genera, *Spiriferina* alone has been thoroughly investigated; but of the others much still requires to be learnt before the value of their respective characters or distinctions can be satisfactorily established. MM. Suess and Deslongchamps have already done much towards the elucidation of the interiors of *Merista* and *Suessia*, but we are not yet in a condition to furnish a completely restored illustration of all the parts of which their interior is composed. *Merista* was in all probability closely related to *Athyris*, and what little we know of *Suessia* would appear to denote that it possessed a very remarkable interior, since, with the external shape of a true Spirifer, it presents many dissimilarities in its internal organization. In *Suessia* the two branches which constitute the first spiral coils are united by a transversal, shelly band, from the centre of which proceeds another short lamella, which is directed towards the bottom of the valve. The species that compose this small group

there appears to be no difference between them in their histological perforations." ('Annals and Mag. of Nat. Hist.,' vol. xvii, 2d series, March, 1856.)

In speaking of *T. sacculus*, Professor M'Coy states ('British Palæozoic Fossils,' p. 411) that "several writers mention their inability to distinguish this species from some of the varieties of *Seminula elongata* and *S. sufflata* of the Permian rocks; but specimens perfectly identical in form and size may be readily distinguished by a small but distinctly marked upward wave in the front margin towards the anterior valve in the Permian fossil, while the margin of the Carboniferous species is nearly or quite horizontal. In *S. sufflata*, also, the mesial septum is much longer and more strongly marked in the receiving valve, extending to within one third of the length of the front margin."

[1] When I published my Introduction in the first volume of this work, the character of *Athyris* had not been fully ascertained.

possess likewise an unusually large hinge-plate, as well as two singularly shaped appendages, which, arising from the inner socket walls, follow an inward direction. No other member of the Spiriferidæ have presented those arrangements; and it is possible that when the interior shall be completely known, that they may be considered of more than sub-generic importance. As to *Cyrtia*, *Retzia*, and *Uncites*, much requires to be done before their characters or value as sub-genera can be completely determined.[1] In the British Permians, the genera *Spirifera*, *Athyris*, and the sub-genus *Spiriferina*, are hitherto alone represented.

*Genus*—SPIRIFERA, *Sowerby*.

(See General Introduction, Vol. I, p. 79, 1853.)

SPIRIFERA ALATA, *Schlotheim*, sp. Plate I, figs. 23—36; Pl. II, figs. 6, 7. (King's Monog., pl. ix, figs. 1—17.)

TEREBRATULITES ALATUS, *Schlotheim*. Leonhards. Taschenbuch, vol. vii, p. 58, pl. ii, figs. 1, 2, 3, 1813.

— UNDULATUS, *J. de C. Sowerby*. Mineral Conchology, vol. vi, p. 119, pl. 562, fig. 1, March, 1827.

— CORDIERI, *Robert*. Atlas du Voyage de la Commission scientifique du Nord, pl. xix, fig. K, 1845.

*S. alata* varies considerably in shape, according to age and individual. When adult or full grown it is transversely fusiform, being twice, and even three times, as wide as long (Pl. I, figs. 23 and 27). Valves convex, deepest at a short distance from the umbone; hinge-line as long as the greatest width of the shell, the cardinal extremities being more or less attenuated in different individuals. The area is wide, with sub-parallel sides; fissure triangular, and in great measure covered by a convex pseudo-deltidium; a narrow rudimentary area may be seen likewise in the smaller valve; beak small and incurved. The mesial fold is simple, of variable width, and flattened along its upper surface; while in the ventral valve there exists a shallow sinus, interrupted by the presence of a rounded, slightly elevated mesial rib. The valves are likewise ornamented by a variable number of rounded, or but slightly angular, ribs; these are simple, or here and there augmented by an occasional intercalation. In number they vary from about eight to thirty on each valve, the larger number occurring on the most adult individuals. The

[1] I have published these few observations in the second volume of the 'Bulletin de la Soc. Linnéenne de Normandie,' 1857.

ribs are also at times of unequal width, even on the same example; and the entire surface of the shell is ornamented by close and regular scale-like, concentric, imbricated laminæ.

In the interior, the spiral cones fill the larger portion of the shell, as may be perceived by a glance at the illustration (Pl. I, fig. 27), drawn from a beautiful specimen in the collection of Mr. Kirkby. The principal lamellæ are here attached, as in all *Spiriferas*, to prolongations departing from the base of the inner socket walls.

The shell-structure has been stated by Professor King to be minutely punctuated, but neither Professor M'Coy nor myself have been able to recognise any trace of those tubular perforations;[1] nor does the interior itself present those peculiarities which accompany the perforated test of *Spiriferina*. The interior of the ventral valve does not show a trace of that elevated mesial septum which is always present in *Spiriferina cristata*, *Sp. octoplicata*, *Sp. Münsteri*, *rostrata*, *Tessoni*, and other forms composing that sub-genus. The dental or rostral plates in *S. alata* are also much smaller, and I might almost say rudimentary; the muscular impressions are likewise exactly similar to those peculiar to the genus *Spirifera*. In the ventral valve the adductor (A) forms a small, lengthened, oval impression, apparently divided by a minute mesial ridge or raised line, and on either side of the adductor are seen the larger scars left by the cardinal muscle (R): these are well displayed on the numerous internal casts found at Humbleton Hill, and of which Pl. II, figs. 6, 7, are illustrations. The ovarian spaces (O) are likewise clearly defined on most specimens; and some of the vascular markings have been described by Professor King.

In the dorsal valve, under the extremity of the umbone, there exists a small striated cardinal process or boss, but no hinge-plate, and a little lower down is seen the quadruple impression left by the adductor (Pl. I, figs. 31, 32, 33 A).

Professor King seems to have misunderstood the impressions visible on the internal casts of this valve, for he describes the smooth space above the central pair as the "posterior division of the valvular muscle," and our central pair as the "anterior division of the same muscle,"[2] thus placing one pair above the other, while in reality both are situated almost on a level (figs. 32 and 33). If the reader will kindly refer to the casts of the Carboniferous *Spirifera trigonalis* (Part V, Pl. V, figs. 26, 27) he will perceive how strikingly they agree with those of the Permian shell. It is, therefore, evident that the internal arrangements alone denote an imperforated species. Most authors are now of opinion that *Sp. undulata*, Sowerby, is only one of the numerous variations in shape of Schlotheim's *Sp. alata*, to which I must certainly add one or two of Professor King's illustrations of his *Sp. Permiana* (pl. ix, figs. 18, 19, and 20).

The study of a large number of specimens of *Sp. alata*, collected by Messrs. Howse

[1] Dr. Carpenter has examined the intimate shell-structure, and, having scaled off large flakes from a well-preserved specimen (a thing that could not be done to any perforated shell, as it does not split thus into laminæ), he did not find the least vestige of anything that could be called perforations, the shell-structure being in all respects analogous to the *Rhynchonella* type.

[2] 'Monograph,' page facing pl. ix, fig. 6.

and Kirkby, have proven to my entire satisfaction that the hinge-line was at times shorter than the greatest width, nor was the shell always so extremely transverse (Pl. I, figs. 24, 25, 30) as is commonly the case with full-grown individuals (Pl. I, figs. 23, 27); but I feel less certain regarding Professor King's figs. 21 and 23. The distinctive characters of *Sp. Permiana* have not, in my humble opinion, been sufficiently established to warrant the present adoption of that species.[1]

*Sp. alata* is distinguished from *Sp. laminosa* of the Carboniferous period, which it sometimes resembles by its more transverse shape.

The largest British specimen I have been able to examine measured 14 lines in length, 32 in breadth, and 11 in depth.

*T. alata* is not a very common species in England. It has been found at Tunstall and Humbleton Hill, Midderidge and Tynemouth Cliff. On the Continent it occurs at Pössneck, Röpsen, &c.; Bell-Sound, Spitzberg. (De Koninck.)

SPIRIFERA? CLANNYANA, *King*. Plate I, figs. 47—49.

MARTINIA CLANNYANA, *King*. Catalogue of the Organic Remains of the Permian Rocks of Northumberland and Durham, 19th August, 1848; and Monograph of English Permian Fossils, p. 134, pl. x, figs. 11—13, 1850.

— WINCHIANA? *King*. Catalogue, p. 8; and Monograph, p. 135, pl. x, figs. 14—17.

This small shell is almost circular, and sometimes slightly emarginate in front; as wide, or a little wider, than long; valves unequally convex; hinge-line shorter than the

[1] Professor King believes his species well characterised, and kindly forwarded for my inspection the young example, fig. 23 of his plate; but Sowerby's drawing is not very correct, for the specimen is much more regularly semicircular, and possesses seven ribs, comprising the mesial one. It measures—length $1\frac{1}{2}$, width $2\frac{1}{2}$, depth $1\frac{1}{4}$ lines, and might perhaps be the fry of *Sp. alata?*

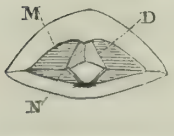
Professor King diagnoses his *Sp. Permiana*—"Margin semi-elliptical, twice as wide as long. Lateral surfaces with four or more sharpish, rather distant ribs; mesial furrow or ridge not much larger than the adjoining folds. Beak erect in casts, but gibbous in testiferous specimens; valves marked with regular lamellæ of growth, crossed with hair-like striæ, rarely exceeding half an inch in length; differs from *Trigonostrata undulata* in having a narrower mesial furrow or elevation, and only half the number of folds, which are broader and more angulated than those of the latter; the valves are not so tumid, and the lateral extremities are rounded instead of pointed." My figs. 35 and 36, Pl. I, approach most to Professor King's *Sp. Permiana*.

*Spirifer Schrenkii*, Keyserling, described and illustrated in Dr. A. G. Schrenk's excellent work, 'Reise nach dem Pordosten des Europöischen Russlands durch die Tundren der Samogeden,' vol. i, p. 88, 1848; and vol. ii, p. 106, pl. iii, figs. 20—30, 1854, appears to be closely related to *Spirifera alata*, but is well distinguished by the absence of the rib which exists in the sinus of the ventral valve of Schlotheim's species.

width of the shell; cardinal angles rounded, area triangular, fissure large and partly concealed by a pseudo-deltidium; beak rounded and elevated. The dorsal valve is but slightly convex, with a mesial depression or furrow, commencing at a short distance from the moderately inflated umbone, and extending to the front; it also possesses a small triangular area. The ventral valve is by far the deepest and most convex, with a mesial furrow originating at a short distance from the extremity of the beak, and extending to the front. The external surface of the shell is covered with numerous closely set and inclined hair-like spinules.[1] In dimensions it does not in general exceed—length 2, width 2, and depth $1\frac{1}{2}$ lines.

This interesting little species appears to be so closely related to the Carboniferous *Sp. Urei* of Fleming,[2] as well as to the Devonian *Sp. unguiculata* of J. de C. Sowerby and Phillips,[3] that I am still uncertain whether it is in reality distinct, or simply a variety or race slightly modified by time? After a minute examination of some well-preserved examples of *Sp. Urei*, which I had obtained through the kindness of Dr. Fleming and of another friend in Scotland, and having ascertained that they had been likewise covered with spinules, I requested Professor King to compare my Carboniferous specimens with those of his Permian shell, and he has transmitted the following observations: "*Sp. Urei* and *Sp. Clannyana* are, I am decidedly of opinion, distinct species, though apparently allied to each other. *Urei* differs from *Clannyana* in being a wider shell; it has the umbone more incurved, the area of the small valve not so deep. The dorsal valve is more excavated, and, as it were, towards the postero-lateral angles. The spines decidedly less numerous, and the median sulcus more pronounced on both valves."

The double area, so like that of some *Orthis*, is well displayed in this little shell; but it cannot be considered a character of generic value, as such likewise occurs to a greater or lesser extent in many species of *Spirifera*, such as in *Sp. striata* and *Sp. alata*, but more especially so in *Sp. decora* of Phillips. Professor King and Mr. Howse are of opinion that *Sp. Clannyana* should be generically separated from *Spirifera* proper, and have placed it in M'Coy's *Martinia*, a genus I have hitherto declined adopting, from its not appearing to be founded upon any important or valid internal character. I have therefore deemed it preferable to allow the shell under description to remain (provisionally at least) under *Spiri-*




*Sp. Clannyana*, seen from the beaks, enlarged.
*M.* Area of ventral valve. *D.* Deltidium. *N.* Area of dorsal valve.

[1] These spines were first noticed by Baron Schauroth, in his 'Ein Beitrag zur des deutschen Zechsteingebirges,' fig. 16, 1853, and afterwards in his 'Ein neuer Beitrag zur Palæontologie,' 1856. Their existence is now also admitted by Professor King, in his Notes on Permian Fossils ('Annals and Mag. of Nat. Hist.,' March and April, 1856); and Mr. Howse informs me that he was in error when he stated in his paper in the 'Annals' for 1847, that the surface does not appear to be covered with spines.

[2] 'History of British Animals,' p. 376, 1828; and Ure's 'History of Rutherglen,' pl. xiv, fig. 12, 1793.

[3] 'Geol. Trans., 2d series, vol. v, pl. liv, fig. 8; and Phillips's 'Palæozoic Fossils of Cornwall,' &c., p. 69, pl. xxviii, fig. 119, 1841.

*fera*, from which it may be hereafter removed, should the study of its interior demonstrate the necessity. Mr. Morris has combined *Martinia Winchiana*, King, with *M. Clannyana*,[1] a view likewise adopted both by Baron Schauroth and Mr. Howse, and in which I should also feel inclined to concur. Professor King, however, still insists upon the separation, but the distinctions proffered do not appear to me to have been satisfactorily made out, and seem more individual than specific.

*Loc. Sp. Clannyana* has been collected rather abundantly at Ryhope-field House. One example was also found at Tunstall-hill by Mr. Kirkby, and another from Pallion may be seen in the Sunderland Museum. Professor King names Whitley as the locality whence he obtained his *Sp. Winchiana*. German examples have also been discovered at Pössneck by Baron Schauroth.

### *Sub-Genus*—Spiriferina, *D'Orbigny*.

(Introduction, Vol. I, p. 82, 1853.)

Spiriferina cristata, *Schlotheim*, sp. Plate I, figs. 37—40, 45, 46; Plate II, figs. 43—45. (King's Monog., pl. viii, figs. 9—14.)

Terebratulites cristata, *Schlotheim*. Beitr. z. Naturg. d. verst in Akademie der Wissenschaften zu München, tab. i, fig. 3, 1816.

This variable shell is more or less transversely semicircular, moderately convex or inflated; the hinge-line as wide or slightly shorter than the greatest width of the shell. The cardinal angles are more often rounded (Pl. I, fig. 40), rarely prolonged with acute terminations (Pl. II, fig. 43). Area large, triangular, flat, or slightly concave, and placed at almost right angles to the plane of the smaller valve, so that the beak is not often seen to protrude to any extent beyond or above its termination. The fissure is rather wide, triangular, and partially covered by a pseudo-deltidium. The number of ribs which ornament the shell varies considerably, both according to age and individual; the central one in the dorsal valve (which represents the mesial fold) is, in general, twice as wide as those which cover the lateral portions of the valve; its crest is angular throughout, or more or less flattened, especially towards the front. In profile it presents a regularly convex curve, but in some individuals is slightly bent upwards near the front. In the ventral valve the sinus is more often deep and angular, but is also sometimes flattened along its centre. From four to fourteen angular or rounded ribs, of greater or lesser width and depth, ornament each valve. When quite young, with dimensions not exceeding one to one and a half line in length, and about the same, or a trifle more, in width

[1] 'Catalogue of British Fossils,' 2d edition, 1854.

(Pl. II, fig. 45), from four to six ribs were only developed, and in this condition resemble the var. *Jonesiana* of King; but most examples of *Sp. cristata* possess from eight to ten ribs; while a remarkable and unusually large individual, obtained at Tunstall hill by Mr. Kirkby (Pl. II, fig. 43[1]), presented fourteen on either valve, and so closely did this specimen resemble some of Sowerby's typical examples of the Carboniferous *S. octoplicata*, that it is very probable if not entirely certain that *Sp. cristata* is at most but a variety or race, slightly modified by time and circumstance, of the Carboniferous species.[2] In the Permian period it was, however, in general a smaller shell, the number of ribs likewise frequently less numerous (Pl. I, fig. 38; and Pl. II, fig. 44). The external surface and ribs are intersected at close intervals by many concentric laminæ, or ridges of growth. Its shell-structure has been described by Professor King as closely perforated, the canals being large, and (according to Professor M'Coy) half their diameter apart.[3] In the interior of the ventral valve two short diverging dental or rostral shelly plates form the fissure-walls, and between these a sharp elevated mesial septum arises, and extends along the bottom of the valve from the extremity of the beak to less than half its length, the sharp elevated extremity dividing the upper portions of the two spiral coils. In the dorsal valve the spiral cones are attached to prolongations of the inner socket-walls, and occupy a large portion of the interior of the shell with their numerous convolutions,[4] as may be seen in the enlarged illustration (Pl. I, fig. 40), taken from a beautifully perfect individual from Humbleton hill, and forming part of Mr. Kirkby's valuable collection. A short and small mesial septum seems likewise to exist in the smaller valve. The dimensions taken from two British examples have produced—

Length 5, width 9½, depth 5 lines (the largest known).

„ 4, „ 7, „ 4 lines.

*Loc.* *Sp. cristata* does not appear to have been a very common fossil in England, and especially so with its shell preserved. Professors Quenstedt and King, Mr. Howse, and others have found it in the shell limestone of Humbleton and Tunstall hills, Hylton, North Farm, and Tynemouth Cliff. On the Continent it is mentioned by Schlotheim, Dr. Geinitz, and Baron Schauroth, from Glücksbrunn, Könitz, Pössneck, Altenstein, Schwaara, and Röpsen; and was found by Mr. E. Robert at Bell Sound, Spitzberg.[5]

[1] This specimen was first figured by Mr. Howse, in pl. iv, figs. 5 and 6, of the nineteenth volume of the 'Annals and Mag. of Nat. Hist.,' January, 1857.

[2] See *Spiriferina cristata*, var. *octoplicata*, in our Part V, p. 38.

[3] Professor King has described singular casts of the tubular perforations visible on the surface of the greater number of internal casts from Humbleton hill.

[4] This and other individuals which I have been able to examine, have presented from eleven to twelve convolutions in each of the spiral cones. The crural processes were not united by a shelly band, as was found to be the case in some examples of *Spiriferina rostrata*.

[5] Refer to De Koninck's 'Nouvelle notice sur les fossiles du Spitzberg,' vol. xvi of the Académie Royale de Belgique, No. 12 des Bulletins.

SPIRIFERINA MULTIPLICATA, *J. de C. Sowerby.* Plate I, figs. 41—44.

SPIRIFER MULTIPLICATUS, *J. de C. Sowerby.* Geol. Trans., 2d series, vol. iii, p. 119, 1829; but described and illustrated for the first time by Professor King, p. 129, pl. viii, figs. 15—18, of his Monograph of English Permian Fossils, 1850.

— — var. JONESIANA, *King.* Mon., p. 129, pl. viii, fig. 19.

Shell small, rarely exceeding 5 lines in length, by 6 in breadth and 4 in depth; is more or less transversely oval, and often very much rounded in outline; valves convex, and sometimes much inflated. The hinge-line is shorter than the width of the shell; beak more or less produced, elevated, and incurved; area triangular, slightly concave, and varying in dimensions (Pl. I, fig. 44[1]); fissure wide, and partially covered by a pseudo-deltidium. From the narrowness of the area, the sides of the beak are more or less visible, as well as its incurved extremity. The ribs are small, rounded, and rarely exceeding ten in number; mesial fold not much produced, and either rounded or flattened along its crest. The sinus in the ventral valve presents a moderate depth, and the entire surface of the shell is covered by numerous concentric laminæ or ridges of growth; shell-structure perforated; the canals are (stated by Mr. Howse to be) smaller than those in *Sp. cristata.* The internal details, according to Mr. Kirkby, differ a little from those already described in the preceding species; the whorls of the spiral are not so numerous, the spirals are not so obliquely placed, and the first branch of the coil is not so angulated.

I have felt considerable uncertainty as to whether the present shell should or not be considered specifically distinct from *Sp. cristata.* Some authors, while admitting the relationship existing between the two, are still of opinion that they should not be united, on account of the smaller dimensions of *Sp. multiplicata,* its rounded outline, more elevated and incurved beak, smaller and less angular ribs, and proportionately wider and more flattened mesial fold. That, on the contrary, *Sp. cristata* is more acutely triangular, the beak less elevated, the ribs more numerous, their sharpness and depth greater, and the intimate shell-structure somewhat different; but, after a minute examination of a very numerous series of both, I found that, although many examples of the shell under description were easily distinguishable from *S. cristata* by the means of the characters above specified, a great number left me in much uncertainty as to which of the two they in reality did belong, for many individuals possessed the same number of ribs, and the other distinctive characters became also much attenuated in their respective values. Professor King allows me to state that he now begins to think that *Sp. multiplicata* may perhaps be a variety of *cristata,* an opinion in which I entirely concur; but, as some uncertainty still

[1] This remarkable specimen, from Tunstall hill, forms part of the collection of the Geological Survey of London. It measures—length 6½, width 6, and depth 6 lines.

exists relative to the question of absolute identity, it will be preferable for the present to allow both Schlotheim's and Sowerby's shells to retain their distinctive appellations. The *Trigonostrata Jonesiana* of King appears to Messrs. Howse, Kirkby, and myself to be only a more rounded form or variety in shape of *Sp. multiplicata,* and was so considered by Professor King himself until 1850, when he removed it on account of its lesser width, more prominent umbone, and higher area; the ribs being also more evenly rounded and at a greater distance from each other, the median one on the smaller valve more evenly convex, and its corresponding furrow in the opposite valve more evenly concave; but these differences brought forward by that author seem to be those common to many young individuals of the Sowerby shell, and cannot, in my opinion, claim a specific distinctive denomination.

*Sp. multiplicata* is not very rare in the shell and compact limestone of Tunstall and Humbleton hills, and at Dalton-le-Dale.

### *Genus*—Athyris, *M'Coy.* = *Spirigera,* D'Orb.

Spirigera. Introduction, vol. i, p. 87, pl. vi, figs. 65—70, 79, 1853.

*Obs.* With the desire to obviate and correct a zoological misnomer, I proposed, in 1853, to adopt the generic designation *Spirigera,* D'Orb., for such shells as *T. concentrica, pectinifera, de Roissyi,* &c., and to retain that of *Athyris,* M'Coy, for such as *T. tumida, Herculea, scalprum,* &c. But this arrangement not having met with the entire approval of several distinguished friends, I have willingly complied with their desire by re-establishing *Athyris* as typified by *A. concentrica, pectinifera,* &c., while for such shells as *T. tumida, Herculea,* &c., that of *Merista,* Suess, has been adopted.[1] The external and some of the internal characters are already well known; but it is not until lately that the arrangement, attachment, and connecting process of the two spiral cones has been discovered, and which will be found fully described under *A. pectinifera.*

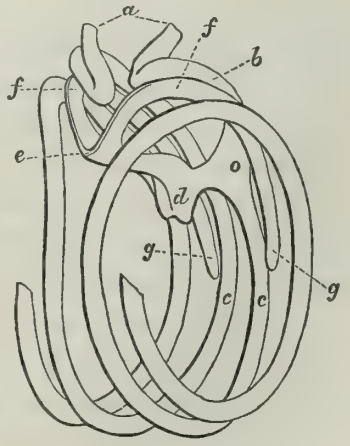
In France and in Germany the term *Spirigera* is generally adopted and preferred to that of *Athyris,* and I cannot but say with good reason; but the law of priority obliges us to retain that of *Athyris* as a mere generic appellation, for it would not be just or fair to repudiate that of M'Coy on account of its erroneous interpretation or etymology, as long as so many other equally objectionable names are allowed currency in science.

[1] French edition of my General Introduction, in vol. x of the 'Transactions of the Linnean Society of Normandy.' Also in the German edition, published by M. Suess.

ATHYRIS PECTINIFERA, *J. de C. Sowerby*. Plate I, figs. 50—56; Plate II, figs. 1—5.

ATRYPA PECTINIFERA, *J. de C. Sowerby*. Min. Con., vol. vii, p. 14, pl. 616, 1840.
CLEIOTHYRIS PECTINIFERA, *King*. Monograph of British Permian Fossils, p. 138, pl. x, figs. 1—10, 1850.
SPIRIGERA PECTINIFERA, *Howse*. Annals of Nat. Hist., vol. xix, 2d series, p. 51.
ATHYRIS PECTINIFERA, *Dav*. Bulletin de la Soc. Linnéenne de Normandie, vol. ii, p. 14, pl. i, figs. 1—7.

This shell assumes in general a more or less rounded shape, is transversely oval, rather wider than long, and in dimensions (with its fringe) rarely attaining 12 lines in length by 14 in breadth. The valves are almost equally deep and convex; the beak of the ventral valve is short, incurved, and perforated at its extremity by a small circular foramen. The external surface is regularly covered by numerous concentric scaly ridges of growth, from each of which radiate closely set fringes of elongated, somewhat flattened, spines (Pl. I, figs. 50, 52, 54; Pl. II, fig. 2). In the interior, the hinge is strongly articulated, the dental or rostral plates offering by their position much solidity to the beak of the ventral valve; between these we find located the extremity of the beak of the smaller valve, as well as the cardinal or hinge-plate, which is not very largely developed in the present species. This hinge-plate is likewise perforated close to its summit (under the umbone) by a minute circular aperture,[1] destined in all probability for the passage of the intestine? as we know that this organ occupies a place about similar in other genera (*Rhynchonella*, &c.) of which the animal has already been studied. On each side of this small hinge-plate and of its aperture, exists a prolonged testaceous plate, situated at a higher level, and forming the ledge or rim of the inner socket-walls. These two prolongations become lengthened, and give birth (while serving as points of attachment) to the two lamellæ (*a*), which, by their convolutions on either side, constitute the spires, as well as the intermediate process by which they are united. These spiral lamellæ, disposed vertically to the plane of the valve, converge at first, then bending suddenly upon themselves, at a short distance from their origin, outwards and backwards (*b*), in the shape of a half circle, which, passing first close to the sockets (*b*), then follows in the direction of the bottom of the valve (*o*, *c*), to become




[1] The hinge, the rostral plates, and the position of the minute circular aperture in the cardinal or hinge-plate, have been described and figured by Professor King in pl. x, figs. 7 and 9, of his 'Monograph of British Permian Fossils.'

recurved again, and thus producing the first of the seven or eight convolutions of which each cone is composed. From the first two spiral lamellæ spring up perpendicularly other two secondary ones (*o*, *d*), which, by being bent, become united towards the middle of the shell (*d*) between the two spiral cones, and afterwards form but a single branch (from *d* to *e*). This last, after having attained the upper level of the spire (at *e*), becomes again bifurcated, and forms other two lamellæ (*f*) recurved in half circle, and terminating backwards by a free extremity (*g*) between the first and second coil of each spiral cone.

*Obs.* The discovery of the perfect example from which the above description has been taken is entirely due to the zeal of Mr. Howse, who, along with Mr. Kirkby, had kindly (and at my especial request) worked for several days in the quarry of Humbleton hill, in the hopes of obtaining a specimen wherein the connecting process of the two spirals could be satisfactorily viewed. It was not, therefore, until the 17th of September, 1856, that material sufficiently perfect could be found so as to admit of a clear definition of this singularly complicated system of lamellæ, so difficult to describe, but which will be readily understood by a glance at our several illustrations.[1]

In 1840 Mr. J. de C. Sowerby figured (in tab. 616 of the 'Mineral Conchology') an imperfect specimen (54 of our Pl. I), in which the perpendicular lamellæ (T) are seen to spring up from the first two spiral coils, as we have already described, and another (Pl. I, fig. 53) in which a small unexplained portion of the connecting process was exhibited (L). In this last example the attachment of the short bent lamellæ to the prolongations of the hinge-plate are likewise imperfectly displayed.

Mr. J. de C. Sowerby and Professor King have referred to the pectinated character of the spiral process, and to this I have likewise devoted some attention. The appearance is considered by Mr. Howse to be more deceptive than real, and entirely due to a foreign substance which encrusts the internal portions of the larger number of specimens. Although this is to a certain extent correct, and that some spirals have not presented a trace of pectinations, others were so distinctly marked, that after a careful examination I felt disposed to believe that the appearance was in a measure due to short spines (Pl. II, fig. 5), similar to those first described by myself as existing on and near the edge of the coils of *Spiriferina rostrata*, *S. Münsteri*, *Ter. resupinata*, and other species, as will be seen by a reference to Part I of the present work.

The fringes which so closely encircle both valves are likewise of much interest; and it will be perceived (Pl. I, fig. 55) that the spinose extremities become at times flattened and expanded, so as to produce small plates of a limited extent.

M. De Verneuil and Professor King have alluded to the resemblance which appears to exist between the Carboniferous *Athyris Roissyi* and the Permian *A. pectinifera;* but, besides the more developed sinus peculiar to the Carboniferous shell, there would seem to

[1] A small example had also been observed in the collection of the British Museum by Mr. S. P. Woodward, but not nearly as perfect as the one discovered by Mr. Howse (Pl. II, fig. 2).

exist also a slight difference in the shape of the intermediate process which unites the spiral coils; and until this point has been clearly ascertained, it will, I think, be preferable to consider both separate, although closely allied, species. There also appears to exist some difference in the external spines.[1]

*Loc.* *A. pectinifera* appears to be a rather uncommon shell in the limited number of localities where it has been hitherto discovered. In England it has been found from the shell limestone of Tunstall, Humbleton, and Hylton, and in the magnesian conglomerate of Tynemouth, and by Messrs. Howse, Kirkby, and Professor King. In the German 'Zeichstein' it is described from Milbite, Corbusen, and Gera. Also from Kirilof, Tioplova, and Bielebei, in Russia.

## *Family*—RHYNCHONELLIDÆ.[2]

### *Genus*—Camarophoria, *King*, 1846.[3] Plate II.

(*Vide* General Introduction, Vol. I, p. 96, 1853.)

The external and internal characters of this excellent genus have been fully described by Professor King, and again detailed in the General Introduction to the present work, so that there remains but little further to be added to what has been already published.

The excellent material in the possession of Messrs. Howse and Kirkby has, however,

[1] M. De Verneuil observes that "*T. pectinifera* differs from *T. Roissyi* but by the absence of a sinus in either valve, and by the horizontality of its margin, comprised in a same plane. It is probable enough that it is but a variety, and that specimens will be found which will connect the two species together; but it would deserve not the less to be considered as a remarkable variety, by its preponderance more at one epoch than at another; for in Russia, as in England, *T. pectinifera* is peculiar to the Permian system, and if it exists in the Carboniferous system of Belgium, it is at least exceedingly rare."

*Terebratula Royssiana*, Keyserling, 1846 ('Reise i d. Samojedenland' of Dr. Schrenk, vol. ii, p. 109, pl. iv, figs. 31—33), belongs to the genus Athyris, and is specifically different from *A. Royssii*, Lev., as well as *A. pectinifera*.

[2] The occurrence of the genus *Rhynchonella* in the Permian period was noted by D'Orbigny at p. 167 of the first volume of his 'Prodrome de Paléontologie Stratigraphique' (1849), as typified by *Terebratula Geinitziana*, De Verneuil, a shell found by the authors of the 'Geology of Russia,' at Schedrova, near the mouth of the Vaga (Dvina), as well as by Count Keyserling in the uninhabited forests near the river Oukhta (province of Archangel), Russia.

From not being acquainted with this shell, and having overlooked its mention as a *Rhynchonella*, I queried the existence of the genus in the Permian period when publishing the Tables contained in the English, French, and German editions of my General Introduction. It must, however, be observed, that

[3] 'Annals and Mag. of Nat. History,' vol. xviii, August, 1846.

enabled me to offer a few additional illustrations, in which certain parts are perhaps more completely expressed. Thus, fig. 25 shows the hinge and different shelly processes in a very distinct manner, as well as do the detached valves, figs. 15 and 24; but the point on which I should desire to direct more particular attention is to those defined and often deeply indented impressions visible or either side of the septa (as seen in the casts, figs. 11, 12, 13, 14, and 23), and which I am disposed to believe are in a great measure due to the adductor (A) in the dorsal, and to the cardinal muscles (B) in the ventral valves. Professor King does not appear to coincide in this interpretation; but when I compare these markings with those observable in the interior of *Rhynchonella*, I am naturally led to conclude from their shape and position that they may be attributable to a similar origin.

Three species only have been discovered in British Permian localities, and they present the same internal details, which appear to be simply more or less developed, according to the dimensions and age of the individual. In the ventral valve the dental plates are

from D'Orbigny having placed *Camarophoria Schlotheimi*, along with *Rhynchonella Geinitziana*, in the same genus, it is evident the French author was neither acquainted with their internal character nor dissimilarities. More merit is therefore due to M. De Verneuil and to Count Keyserling for having placed the two above-named shells in separate genera, and particularly to Professor King, who first described their differences.

*Rh. Geinitziana* was likewise found in Germany by Dr. Geinitz and Baron Schauroth; and it was while describing some examples of this last from Röpsen, near Gera (in the 'Annals of Nat. Hist.' for March and April, 1856), Professor King announced for the first time that, in his opinion, the shell-structure was regularly perforated as in *Terebratula*. So anomalous a condition in a genus and family where all the species hitherto examined by Dr. Carpenter had proved to possess a fibrous *non-perforated* texture, made me very desirous that the subject should be further investigated before the statements made by Professor King should be admitted as an established fact. I therefore obtained, through the kind medium of Count Keyserling and General Helmersen, the loan of those Russian individuals collected by Count Keyserling near the river Oukhta, and which form part of the collection of the "Corps des Mines" of St. Petersburgh. M. De Verneuil likewise kindly communicated his original specimen, and to which were added others from German individuals, presented to me by Baron Schauroth and Professor King. These I submitted to Dr. Carpenter, who, on the 17th of February, 1857, after a careful and minute microscopical examination of *shreds*, removed in my presence from the exterior of the best preserved of the Russian shells, declared that he could perceive no perforations in their outer layer, but that in the German examples the inner surface was covered with minute pits, such as are seen on the outer surface of Poranbonites; but at that period Dr. Carpenter had not made any vertical sections through the entire thickness of the shell. But as Professor King had observed numerous dots on the Russian and German specimens which he considered to be due to perforations passing directly through the entire thickness of the shell, the specimens and preparations made were shown by Dr. Carpenter to Professors Quekett and Salter, who both entirely coincided in the opinion expressed on the 17th of February, viz., that the outer or first-formed layer (in perfectly preserved specimens) was not perforated; but also agreed that a considerable thickness of the inner ones were perforated, and which last corresponded with the portion of the shell examined by Professor King. Therefore, although it appears certain that a part of the thickness of the shell is traversed by passages, there exists an external layer quite free from such, so that the shell-structure cannot be considered exactly the same as in *Terebratula*.

conjoined at their dorsal margins, forming a trough-shaped process, affixed to a low medio-longitudinal plate (Pl. I, figs. 24, 25, 27). In the dorsal valve the space between the sockets is occupied by a small cardinal muscular process or boss, on either side of which are two long, slender, curved processes, and to which were no doubt attached the free cirriated spiral arms: from beneath the cardinal process a high vertical mesial septum extends to a little more than a third of the length of the valve, supporting along and close to its upper edge a spatula-shaped process, considerably dilated towards its free extremity, and projecting with a slight upward curve to nearly the centre of the shell (figs. 15, 26, 27).

The vascular markings (figs. 13, 14) have been described by Professor King, as well as in my Introduction, and are beautifully preserved on many examples of the larger species from our Permian beds.

CAMAROPHORIA SCHLOTHEIMI, *Von Buch*, sp. Plate II, figs. 16—27; and King's Mon., pl. vii, figs. 10—21; and pl. viii, fig. 8.

TEREBRATULITES LACUNOSUS (part), *Schlotheim*. In Dr. Leonhard's Min. Taschenbuch, 1813.

TEREBRATULA SCHLOTHEIMI, *Von Buch*. Ueber Terebrateln, p. 39, pl. ii, fig. 32, 1834.

This abundant and characteristic species varies less in shape as in the number of its ribs; is wider than long, and somewhat obscurely rhomboidal or sub-pentagonal, the greatest width being situated at about the anterior portion of the shell. The valves are unequally convex, and possess marginal expansions, which, when fully developed, produce a flattened frill, as wide as half the length and breadth of the shell. The dorsal valve is often gibbous, and presents in profile a convex arch, with its marginal expansions slightly bent upwards. The mesial fold differs in width and elevation, according to the number of ribs which ornament its surface, these varying from two to seven in different ages and individuals. On the lateral portion of the valves the ribs are also at times obscurely defined, and vary in number from two to six on either side. The ventral valve is most convex about the beak, this last being small, slightly produced, and incurved, so that the deltidial plates which margin the foramen are but rarely exposed, except in very young individuals: the beak ridges are also but slightly defined; the sinus is of greater or lesser depth, and ornamented by from one to five ribs, which first appear at about the middle of the shell, and extend thence to the front. Shell-structure not perforated.[1] The measurement, taken from a specimen with its marginal expansions fully developed, offered

[1] In page 117 of his Monograph of 'English Permian Fossils,' Professor King describes the shell-texture of *Camarophoria* as possessing extremely minute punctures, but Dr. Carpenter could find none, and pronounced the genus and present species to be "not perforated," at p. 35 of our General Introduction.

—length 10, width 14, depth 6 lines; the same without the expansions—length $6\frac{1}{2}$, width $8\frac{1}{2}$, depth $5\frac{1}{2}$ lines.

In 1816, Schlotheim published his first illustration of the shell under description, but with the mistaken idea that it belonged to the same genus and species as *Terebratulites lacunosus*, a Jurassic shell; and in 1834 Von Buch applied to the Permian shell the distinctive appellation now generally adopted. Professor M'Coy states that *C. multiplicata* of King should be merged into the species under description,[1] and with which Baron Schauroth would likewise combine *C. globulina* of Phillips,[2] but I am not prepared to subscribe to either opinion, because specific differences appear to have been satisfactorily made out both by Mr. Howse and Professor King. The first is a much larger shell, more transversely oval, and possesses a greater number of ribs; nor have I been able to discover the passages which are said to connect it with the Schlotheim species; and it appears also to be distinguished from *C. Schlotheimi* by its much narrower marginal expansions (Pl. II, figs. 15 and 22), a point first mentioned to me by Mr. Howse. *C. globulina* is likewise a well-characterised shell, more globular in shape than either of the others, with only two or three ribs on the mesial fold, and one in the sinus, and has not hitherto exhibited marginal expansions; but I am ready to admit that certain adult examples of Phillips's shell very closely resemble some young individuals of that variety of *C. Schlotheimi* which possess only two ribs on the mesial fold (fig. 19), but both are well distinguished in the adult condition. I do not, therefore, perceive the advantage to be derived from combining these three shells under a single denomination.

Fig. 1.

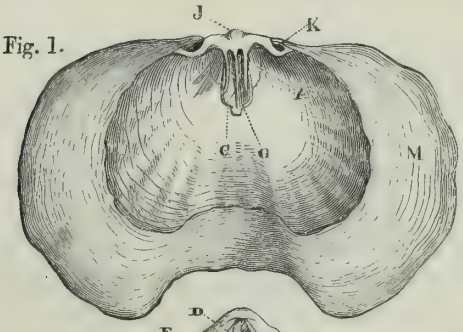



Fig. 2.

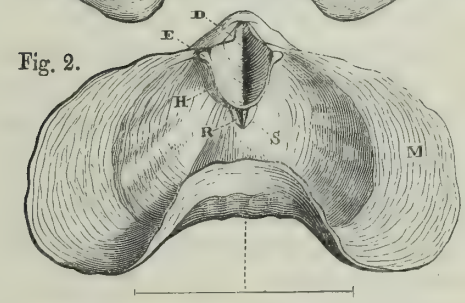



Fig. 1. *C. Schlotheimi.* Interior of the dorsal valve.

Fig. 2. *C. Schlotheimi.* Interior of the ventral valve.

*A.* Adductor muscular impressions? *C.* Curved processes, to which were affixed the fleshy spiral arms. *D.* Deltidium. *E.* Teeth. *H.* Conjoined dental plates, or trough-shaped process. *J.* Cardinal process. *K.* Sockets. *M.* Marginal expansions. *O.* Spatula-shaped process, or visceral support? *R.* Cardinal muscular scars? *S.* Septum.

It has been supposed that *Ter. superstes*, De Verneuil, might likewise be united to the species under description, and certainly some of our British examples of *C. Schlotheimi*

[1] 'British Palæozoic Fossils,' p. 445.

[2] 'Ein neur Beitrag zur Palæontologie des deutschen Zechsteingebirges,' p. 218. Baron Schauroth admits three varieties—*a* var. *multiplicata*, *b* var. *genuina*, and *c* var. *globulina*.

appear to closely resemble De Verneuil's figures; but not having hitherto been able to examine the Russian type, I cannot comment upon its specific merits. M. De Verneuil observes, in the second volume of the 'Geology of Russia,' p. 101, that his species is distinguished by certain slight external characters, such as the more rounded shape and less prominent ribs on the lateral portions of the shell, the last being at times completely wanting, as well as the general contour, which is more triangular than pentagonal.

*Loc.* *C. Schlotheimi* is one of the most common species in the Permian rocks of Humbleton and Tunstall hills, less abundant at Hylton Castle, Silksworth, Ryhope, Dalton-le-Dale, Tynemouth Castle-hill, &c. On the Continent it appears equally abundant at Röpsen, Milbitz, Poëssneck, Corbusen, Schmerbach, &c., in Germany. It is stated by M. De Verneuil to occur in the Carboniferous strata of Russia.

CAMAROPHORIA GLOBULINA, *Phillips.* Plate II, figs. 28—31; and King's Mon., pl. vii, figs. 22—25.

TEREBRATULA GLOBULINA, *Phillips.* Encyc. Met. Geology, vol. iv, pl. iii, fig. 3, 1834.

Shell small, globular, almost as wide as long, with convex inflated valves, ornamented by from six to nine short angular ribs on the dorsal, and five to eight on the ventral valve; of these two, more rarely three, occupy the mesial fold, and one or two the corresponding sinus, thus producing a bisinuated or trisinuated frontal wave. The ribs take birth at about half the length of the shell, and extend to the margin. Beak small, entire, rounded and incurved; foramen minute, with small deltidial plates. No marginal expansions?

Length 4, width 4, depth 3 lines.

*C. globulina* is common in the shell limestone of Tunstall and Humbleton hills, Hylton Castle, Dalton-le-Dale, and Ryhope-house Farm; as also, but more rarely, in the conglomerate of Tynemouth. It was named *T. corymbosa* by Mr. Howse in his 'Catalogue,' but afterwards referred to that of Phillips.

CAMAROPHORIA HUMBLETONENSIS, *Howse.* Plate II, figs. 9—15; and King's Mon., pl. vii, figs. 26—32; and pl. viii, figs. 1—7.

TEREBRATULA HUMBLETONENSIS, *Howse.* Catalogue of the Fossils of the Permian system of the Counties of Northumberland and Durham, T. N. T. C., vol. i, part iii, p. 252, 17th August, 1848; and Annals of Nat. Hist., vol. xix, 2d series, p. 50, pl. iv, figs. 3, 4, January, 1857.

CAMAROPHORIA MULTIPLICATA, *King*. Annals and Mag. of Nat. Hist., vol. xviii, 1st series, p. 28, July, 1846;[1] and a Catalogue of the Organic Remains of the Permian Rocks of Northumberland and Durham, p. 7, 19th August, 1848; a Monograph of the Permian Fossils of England, p. 121, pl. vii, figs. 26—32; and pl. viii, figs. 1—7, 1850.

Shell sub-trigonal or obovate, wider than long, with narrow marginal expansions; dorsal valve inflated and gibbous, presenting in profile a very convex curve; mesial fold wide, rounded, and somewhat flattened along the middle. The ventral valve is most convex at and near the beak, which is rounded and incurved; foramen small, circular. The sinus varies in depth and width, and is likewise flattened along its middle, producing a more or less elevated convex curve in front. About thirty simple or intercalated radiating ribs ornament the surface of each valve, of which from eight to ten occupy the surface of the mesial fold, and from seven to nine that of the sinus of the opposite valve. The dimensions taken from two examples have produced—

Length 13, width 17, depth 11 lines.
„ 11, „ 14, „ $7\frac{1}{2}$ lines.

No testiferous specimens of this large *Camarophoria* have been discovered as yet, and all we know of the species is taken from beautifully preserved internal casts. It is stated to have been found abundantly only in a few localities, and but at times in the shell limestone of Humbleton and Dalton, once in the magnesian conglomerate of Tynemouth.

Mr. Howse has observed that, "after examining an extensive series (of the shell under description and *C. Schlotheimi*), we are obliged to conclude, from the following constant characters, that they are quite distinct. In the present species the form is more ovate, and the sinus much wider and less elevated in front. The ribs are always more numerous, and when they are not bifurcated they are more nearly parallel than in *C. Schlotheimi*. It is also of a much larger size."[2] In p. 121 of his 'Monograph,' Professor King enters upon other details to demonstrate that the *Camarophoria* in question cannot be considered as a large state of Von Buch's species, *C. Schlotheimi*, an opinion in which I entirely coincide. Baron Schauroth sent me several specimens from Ilmenau, under the name of *C. multiplicata*; but these do not agree sufficiently, either in size or detail, with our British shell so as to enable me to pass a decided opinion on the matter, and especially so as the specimens were not in a very perfect or satisfactory state of preservation. It is, therefore, still uncertain whether this large *Camarophoria* has been found in any of the Continental Permian localities.

[1] Unfortunately, in 1846, the term *multiplicata* was neither described nor accompanied with reference to locality or stratigraphical position; it therefore falls under the class of *Catalogue names*, which cannot claim priority should some subsequent author *describe* the same shell under a different name. I am therefore compelled to adopt that given by Mr. Howse on the 17th of August, 1848.

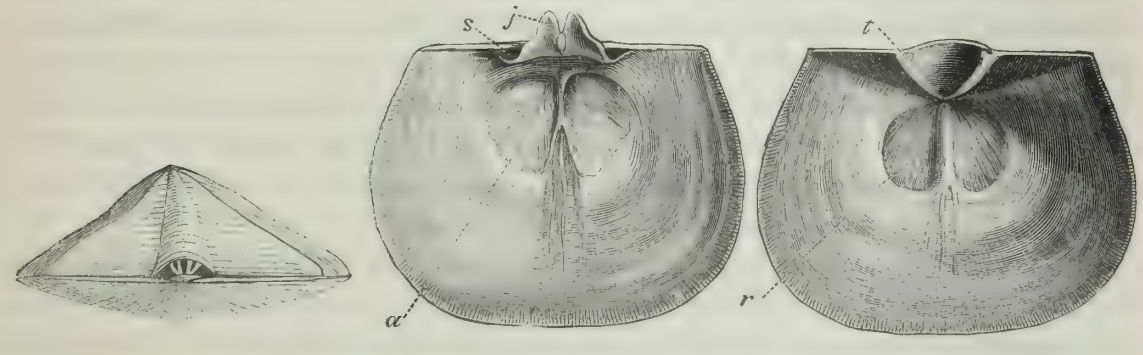
[2] 'Catalogue,' p. 252, 1848.

## *Family*—STROPHOMENIDÆ.

### *Sub-genus*—STREPTORHYNCHUS, *King*.[1]

In 1853 I was tempted to suppose Professor King's genus STREPTORHYNCHUS synonymous of ORTHESINA, *D'Orbigny*, but the perfect interiors, which I have recently studied, have led me to abandon that view, and to consider both to be characterised by certain well-defined peculiarities, which will be better understood by the comparison of the subjoined illustrations.

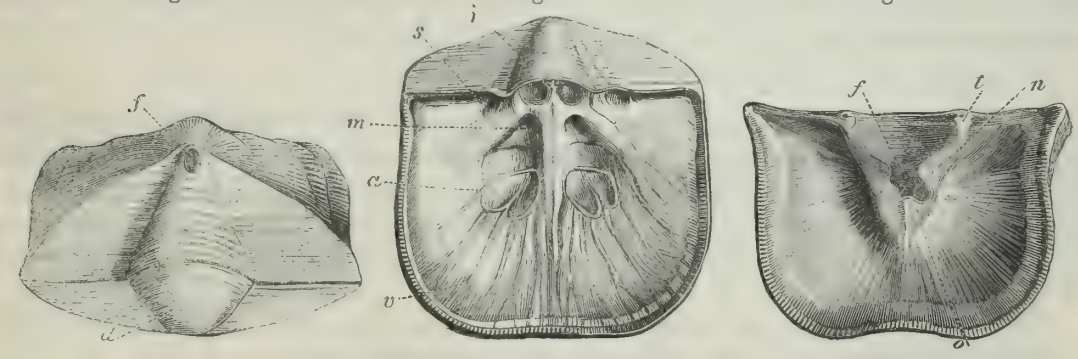
Fig. 1. Fig. 3. Fig. 2.




*Streptorhynchus Devonicus*, D'Orbigny, species.

Fig. 1. Both valves, seen from the beaks. Fig. 2. Interior of the larger or ventral valve, as seen under the area. Fig. 3. Interior of the smaller or dorsal valve.

Fig. 4. Fig. 6. Fig. 5.




*Orthesina anomala*, Schlotheim, species.

Fig. 4. Both valves, seen from the beaks. Fig. 5. Interior of larger or ventral valve, seen under the area. Fig. 6. Interior of the smaller or dorsal valve. *a*. Adductor scar. *d*. A deltidium of the smaller valve. *f*. Foramenal aperture, under side of deltidium. *j*. Cardinal process. *m*. Cavity on either side of the mesial septum. *n*. Dental plates. *o*. Horizontal plate, supported by a septum. *r*. Cardinal muscular impressions. *s*. Sockets. *t*. Teeth. *v*. Vascular impressions.

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[1] 'Monograph of English Permian Fossils,' Palæontog. Soc., p. 109, 1850. Etym. στρεπτω, I bend or twist, and ῥύγχος, a beak.

The sub-genus *Streptorhynchus*, as typified by *Terebratulites pelargonatus* of Schlotheim (Pl. II, figs. 32—42), or by *Leptæna devonica*, D'Orb.,[1] may be characterised as an inequivalved shell, convex or concavo-convex, externally striated. The smaller valve is semicircular, the larger or ventral one possessing a prolonged and oftentimes bent or twisted beak; hinge-line rather shorter than the width of the shell. The area in the larger valve is triangular, with a fissure covered by a convex pseudo-deltidium. A small, narrow rudimentary area exists, likewise, in the smaller valve. No foramen is observable, but the cardinal process is at times seen partially extending under the deltidium, as in the woodcut (fig. 1, p. 29).

In the interior of the larger or ventral valve (Pl. II, figs. 40, 41; and woodcut, fig. 2) a strong hinge-tooth is situated on either side at the base of the fissure, supported by a dental ridge or plate; these diminish in size as they converge under the area towards the extremity of the beak (fig. 40; woodcut, fig. 2 *t*). At the bottom of the valve, under the beak, and extending a little beyond, are the impressions left by the cardinal and adductor muscles, which occupy about one third of the length of the valve; they form two elongated oval scars, more or less deeply excavated, and separated by a rather wide mesial ridge (fig. 40; and woodcut, fig. 2 R).

In the interior of the smaller or dorsal valve the cardinal process is largely developed (figs. 38, 39; and woodcut, 3), being composed of two testaceous projections, which are either slightly convex or concave on the side facing the interior, but grooved or bidentated towards the extremity of their outer surface (fig. 39); the socket-plates are large, and partly united to the lower portion of the cardinal process. Under these, on the bottom of the valve, are seen the quadruple impressions left by the adductor, which occupy more than a third of the length of the valve, and are arranged in pairs, divided by a short rounded mesial ridge.

[1] *Leptæna Devonica*, D'Orbigny, 'Prodrome,' vol. i, p. 90, 1849 = *Orthis crenistria*, var. *Devonica*, De Keyserling, from the Devonian beds of Ferques, which has long been confounded with *Orthis umbraculum*, V. Buch, from the Eifel, certainly belongs to the same section as that typified by *Streptorhynchus pelargonatus*. The woodcuts, figs. 2 and 3, have been made from interiors obtained at Ferques by Mr. Bouchard and myself, and are essentially similar in internal character to those of *S. pelargonata* (Pl. II, figs. 38—41).

The following differences have been pointed out by Mr. Bouchard as occurring between *O. umbraculum*, V. Buch, from the Eifel, and *O. Devonica*, from the Devonian beds of Ferques:

"The first is very constant in its shape, and in that of its area; is concavo-convex—that is to say, its smaller valve is convex, while the larger or ventral one is concave in all fully developed or adult individuals; on both valves the striæ are strongly marked and granulated; the area always regular and narrow.

"*Streptorhynchus Devonicus*, D'Orb., is, on the contrary, very inconstant in its external form: one does not meet with two similarly shaped individuals. It is always bi-convex—that is to say, both its valves are convex, their striæ smooth and not strongly marked. The area assumes every kind of shape, both in height and width; is very often irregularly twisted, being wider than long on one side than on the other; the beak being curved backwards, or inclined to one or to the other side, nothing appearing regular in the shell. Interiorly the details of both are similar."

Such are the general dispositions presented by the shells composing this sub-genus, and which denote its intermediate position between *Orthis* and *Strophomena*. Professor King lays great stress upon the peculiar twisted character of the beak, but it remains still to be ascertained whether this can be considered a common feature of the species which compose the group, or peculiar only to some specimens.

Now, if we compare the shell above described with those of D'Orbigny's *Orthesina*, of which woodcuts figs. 4, 5, and 6 are faithful representations,[1] the differences will be obvious. It will be seen that both valves possess large areas, with convex deltidiums, leaving no open or free space whatsoever between them at the hinge-line (woodcut, fig. 4), but in that of the larger valve, and towards its extremity, is seen a circular or oval aperture, which is in general cicatrized or closed in full-grown shells, but which was open up to a certain age, and evidently affording passages to pedoncular fibres of attachment. No similar aperture ever existed in *Streptorhynchus*, for no trace of such a foramen can be seen in any of the species and numerous specimens that have come under my observation, while it would appear to be a constant character in *Orthesina anomala*, *O. Verneuili*, *O. adscendens*, &c.; and if any fibres of attachment ever existed in Professor King's sub-genus, they must have passed through the small space left between the deltidiums and the cardinal process of the ventral and dorsal valves, a point not hitherto satisfactorily established.

In the interior of the larger valve of *Orthesina* there exists, as in *Streptorhynchus*, a strong hinge-tooth on either side at the base of the fissure; but instead of the small or rudimentary dental plate or ridge peculiar to the last-named sub-genus, in *Orthesina* these last are largely developed, and of a remarkable shape: they first project considerably into the interior, and converge towards the extremity of the beak (woodcut, fig. 5 N), and afterwards bend slightly outwards, and inwards, to form a third curved and connecting plate (*o*). This last is supported by a vertical mesial septum, which extends along the bottom of the valve to about half its length. On either side of this last are faintly-marked impressions, probably due to the cardinal muscle. Towards the extremity of the beak, on the under surface of the deltidium, is seen the foraminal aperture (*f*), surrounded by a raised margin; and the inner surface of the dental plates (N) probably afforded a surface for the attachment of the pedicle muscle, which must have been large, from the extent of the grooved surface. No such characters can be found in the larger valve of *Streptorhynchus*.

The smaller or dorsal valve of *Orthesina* has also its well-marked and peculiar features. Its large area and convex deltidium have already been described. At its base, on either side, are situated two sockets for the articulation of the teeth of the ventral valve: the cardinal process (J) is very remarkable; it is formed of a single projection, with two small

[1] I must express my warmest thanks to Count Alex. V. Keyserling for the kind exertions he made to procure me the means of studying the interior of *Orthesina*; and also to Professor Dr. Schmidt, of Dorpat, for the two beautiful interiors of *Orthesina anomala*, which he kindly gave me, and from which the woodcut representations, figs. 5 and 6, have been taken.

lateral depressions, which served no doubt as points of attachment to the cardinal muscles, and is, moreover, entirely covered by the deltidium, leaving a deep conical hole on either side. At a short distance under this is seen a large, strong, mesial ridge,[1] with two lateral ones; between these are situated, on the bottom of the valve, the quadruple impressions left by the adductor (A); two deep holes (*m*), similar to those situated on either side of the cardinal process, are likewise visible on either side, of the commencement of the mesial ridge last described.

These dispositions are also very different from those of *Streptorhynchus*, where the cardinal process is bilobed and completely exposed; nor are the other internal impressions similar in their details. Professor King was therefore justified in his views, although he was unacquainted at the time with several of the distinguishing internal characters of D'Orbigny's genus. Much more, however, remains to be discovered before the numerous species composing the family STROPHOMENIDÆ can be correctly classed, and we cannot be too cautious in our inferences, as the example just given will sufficiently demonstrate.

STREPTORHYNCHUS PELARGONATUS, *Schlotheim*, sp. Plate II, figs. 32—42; and King's Mon., pl. x, figs. 18—28.

TEREBRATULITES PELARGONATUS, *Schlotheim*. Akad. Münch., vol. vi, p. 28, pl. viii, figs. 21—24, 1816.

This little species, which in external shape bears much resemblance to several species of *Thecidium*, is more or less sub-conical or triangular. The smaller or dorsal valve is semicircular, and slightly indented in front, with a shallow mesial depression or furrow, commencing at a short distance from the extremity of the umbone; it possesses, likewise, a narrow rudimentary area. The hinge-line is shorter than the greatest width of the shell. The ventral valve is convex, semi-conical; the beak, in general largely developed, and at times exceeding the length of the smaller valve, is produced, elevated, bent backwards, and often irregularly twisted either to the one or other side. The area is large, triangular, with a fissure covered by a convex pseudo-deltidium. Externally the valves are ornamented by numerous small radiating raised striæ, which augment in number at variable distances from the beaks, both by intercalation and bifurcation, and are likewise intersected by numerous concentric lines of growth. The internal details have been alluded to under the generic characters.

The dimensions attained by this little shell vary considerably in different countries and

[1] Septa are rarely developed in the smaller valve of *Strophomenidæ*; but in one species from the Devonian beds of Ferques, *Orthis Deshaysii*, Bouchard, there exists a largely produced mesial plate, which, commencing under the cardinal process, extends almost to the frontal margin.

localities. Some British examples have measured 7 lines in length, $5\frac{1}{2}$ in width, and 4 in depth, but is commonly a smaller shell; while a few foreign specimens have exceeded the dimensions above given.

The genus, or rather sub-genus, to which this interesting species should be referred has been the subject of considerable difference in opinion. Schlotheim placed it among his *Terebratulites;* J. de C. Sowerby made it his *Spirifer minutus;* Brongniart considered it to be a *Terebratula;* Von Buch named it *Orthis Laspii;* and Professor King created for its reception a new genus, *Streptorhynchus.* In 1853 I left it provisionally with *Orthesina;* and Professor M'Coy places the shell in *Leptæna* (1855). Thus, since 1816, this little species has been located into six different genera by different authors!

The fortunate discovery of several perfect detached valves by Messrs. Howse and Kirkby has enabled me to furnish some additional figures, which will serve to complete our knowledge of its internal characters.

Mr. Howse and Professor King state to have obtained the shell from the shell limestone of Tunstall and Humbleton hills, Dalton-le-Dale, Silksworth, Ryhope-field House, and in the Breccia of Tynemouth Cliff. In Germany Dr. Geinitz, Von Buch, Decken, and Professor Quenstedt mention it from the Lower Zechstein of Röpsen, Corbusen, and Schmerback, as well as from the Zechstein conglomerate of Könitz and Altenstein. Baron Schauroth describes the shell from Pössneck, and M. De Verneuil mentions having found it at Bielagorskaia.

*Family*—PRODUCTIDÆ.

*Genus*—PRODUCTUS, *Sowerby.*

(Introduction, Vol. I, p. 117, 1853.)

PRODUCTUS HORRIDUS, *J. Sowerby.* Plate IV, figs. 13—26. (King's Mon., pl. ix, figs. 29—31; and pl. xi, figs. 1—13.)

PRODUCTUS HORRIDUS, *Sowerby.* Min. Con., vol. iv, p. 17, pl. 319, fig. 1, Jan., 1822
= *Prod. clava,* Sow., Min. Con., pl. 560, figs. 2—6.

This well-known and characteristic fossil has been often described and illustrated.[1]

[1] De Koninck, 'Recherches sur les Animaux fossiles de la Belgique,' and 'Monographie du Genre Productus,' p. 158, pl. xv, fig. 1, &c., 1847. Geinitz, 'Versteinerungen,' p. 15, pl. vi, figs. 1—14, 1848. King, 'A Monograph of the Permian Fossils of England,' p. 87, 1850. M'Coy, 'British Palæozoic Fossils,'

It varies considerably in external shape, but may be said more or less sub-pentagonal or quadrangular marginally; wider than long in most individuals, but sometimes the reverse. The ventral valve is convex and gibbous, with prominent auricular expansions extending on either side of its somewhat attenuated but inflated and incurved beak: there exists, also, a mesial furrow, commencing at the extremity of the beak, and extending to the frontal margin. The smaller or dorsal valve is convex, and of moderate depth, with one or three undulations upon its surface, viz., a mesial and two lateral ones. The hinge-line is as long, or a little shorter, than the greatest width of the shell. There is no area on either valve,[1] nor articulating condyles. On the external surface of the ventral valve a variable number of long, rather large, and hollow spines are regularly scattered; on the dorsal valve they are confined to the vicinity of the cardinal edge, where they assume much regularity in both valves, from being arranged in one or two rows in the proximity of the hinge-line; they also project externally with an oblique angle, and become larger and longer as they approach the lateral margin.[2] The ventral valve is also obscurely ribbed in some specimens, and marked by numerous concentric lines of growth.

In the interior of the ventral valve (fig. 22) the muscular impressions occupy the larger portion of a pear-shaped space at the bottom of the valve, which is chiefly situated under the cavity of the beak. This space is longitudinally divided by a raised, slightly convex callosity, along the upper surface of which are impressed the ramified dendritic impressions of the adductor, longitudinally divided by a small mesial ridge (A of the internal cast, fig. 20, as well as on the beak of fig. 19). On either side there is a deep and strongly grooved or striated subquadrate impression, which is supposed to be due to the cardinal muscle (B of fig. 20[3]), the remaining surface of the interior of the

p. 465, 1855. Quenstedt, 'Handbuch der Petref.,' p. 490, tab. 39, figs. 26—30, 1851. Howse, 'Annals and Mag. of Nat. Hist.,' vol. xix, 2d series, p. 44, 1857, &c. To these works we must refer the reader for more copious details. This *Productus* has also received several names which will be found recorded in the synonyma published by Professors De Koninck and King, and which dates back as far as Hoppe, who, in 1745, was the first to describe the shell.

[1] M. De Koninck, who minutely and carefully describes every particular connected with the external form of this species, states, at p. 160 of his work, that most specimens are deprived of areas, but that with a certain number it exists in a rudimentary state; it appears to me to be but a thickening of the hinge-line.

[2] These spines are well described by Professor King, at p. 90 of his Monograph.

[3] Beautifully preserved internal casts of this *Productus* are not of rare occurrence in the shell limestone of Humbleton hill, and of which figs. 19 and 20 are careful illustrations. Fig. 19 represents the same view of a similar but much less perfect cast, figured by Sowerby under the name of *Productus clava*, in pl. 560, fig. 5, of the 'Mineral Conchology.' I considered it, therefore, desirable to offer faithful representations of these, as such had not been done by other authors, and the more especially so as upon them are seen, in relief, all those impressions which in the shell itself would appear in hollow, as in figs. 21 and 22, which are also drawn from admirably preserved detached valves, in the collections of Messrs. Howse and Kirkby. The internal details relating to this interesting fossil have been more or less completely described by M. De Koninck, Dr. Geinitz, Professor King, Mr. Howse, and others: but I trust that my series of illustrations may also be considered of some interest, as they have been drawn from the best

valve being covered by small pits and rugosities. In the interior of the smaller or dorsal valve (fig. 21) the cardinal process is produced beyond the level of the hinge-line, and varies somewhat in shape in different individuals (figs. 21 and 25, as seen from the interior of the valve; figs. 23 and 24, from the exterior). This boss is bifid at its extremity, with a slit or groove along the middle in each of the lobes facing the exterior of the valve. From the base of this process proceed three ridges or crests; one on each side runs almost parallel to the hinge-line, and the third forms a central mesial ridge or septum, which, becoming more acute and elevated at its extremity, extends to about two thirds of the length of the valve. On either side of this ridge are situated the muscular and reniform impressions; those left by the adductor are of a triangular shape, deeply grooved, and more or less elevated above the level of the valve.

In front of the muscular scars, and about the middle of the valve, are seen two elongated reniform impressions or callosities, bounded by small ridges, which, after dividing the adductors in a perpendicular manner near to the mesial septum, proceed outwardly in an almost horizontal direction, when turning abruptly, form an elongated half circle, which, becoming again horizontal, terminates close to the septum (fig. 21; and cast, fig. 19).[1]

Nearly half of the posterior internal surface of the valve unoccupied by the impressions above enumerated is minutely pitted, denoting, in all probability, ovarian spaces, while the remaining portion is covered with a multitude of short spinose tubercles, which become especially visible near the marginal portions of the shell. There is, also, a row of perforations, due to the cardinal spines, between the hinge-line and the upper pair of ridges which depart from the base of the cardinal process.

material procurable, and in them will be found certain details which have perhaps not hitherto been as carefully delineated. Professor King's description and figures of this shell in his Monograph are very excellent, but, with the exception of his fig. 10, chiefly relate to differences observable in the external shape; so that, by combining mine with his, every external and internal feature, I trust, will have been satisfactorily exemplified.

It must also be observed, that although the adductor impressions in the ventral valve are not so broad as the cardinal ones, they are much more elongated, and placed at variable levels in different examples; thus their lower extremity does not attain the level of the lower margin of the cardinal impressions, or extends beyond them in either direction.

[1] In his excellent description of the interior of the smaller valve of this *Productus*, Mr. Howse observes—"It is generally supposed that the reniform callosities are connected with the vascular system, but this supposition appears to be unsupported by a comparison of these processes with the corresponding parts of other Brachiopods. If we compare them, for example, with the same valve of *Argiope* or of *Thecidium*, genera which show points of resemblance to this in several particulars, we find that these processes have served for the attachment of the oral arms; and this view is supported by all that we know of the position of these arms in both recent and fossil genera,—at least these structures cannot be attributed to the vascular system, or they would undoubtedly be present in both valves, whereas they are confined to one. On some casts of this *Productus* a great number of small parallel grooves or furrows are seen running from the central ovarian region to the anterior margins of the valves; they are not very distinct, but

*Productus horridus* abounds in the shell limestone of Humbleton and Tunstall hills; at the North Point, near Shields; Westol, Hylton Castle, Dalton-le-Dale, Durham; and in the compact limestone of Midderidge, Garmundsway, as well as in the Breccia at Tynemouth Cliff. It is also mentioned from Derbyshire. On the Continent it is found in the lower Zechstein of Röpsen, near Gera; Ilmanau, Könitz, between Bucha and Gosswitz, Glücksbrunn; and on the meridial border of the Shüringer Wald, Pössneck; Corbusen, near Ronnebourg; in Silesia, at Lauban on the Gneis. It was also recognised by M. De Koninck among the fossils brought back by M. E. Robert from Bell Sound, at Spitzberg, &c.

PRODUCTUS LATIROSTRATUS, *Howse*.[1] Plate IV, figs. 1—12.

PRODUCTUS LATIROSTRATUS, *Howse*. Catalogue of the Fossils of the Permian System of the Counties of Northumberland and Durham, in the Transactions of the Tyneside Naturalists' Field Club, vol. i, part iii, p. 256, 17th of August, 1848; and Ann. and Mag. of Nat Hist., vol. xix, 2d series, p. 46, pl. iv, figs. 1, 2, 1857.

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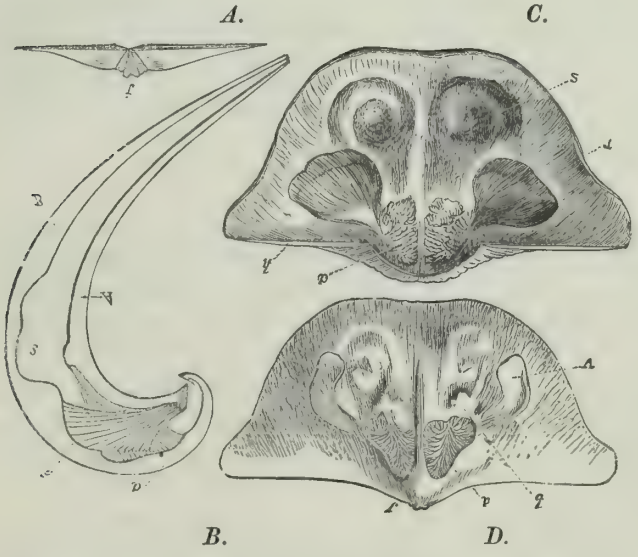
they may perhaps hereafter be found to have been connected with the vascular system. This idea is somewhat strengthened by the appearance of similar lines on some casts of *Spirifer*, which few persons would hesitate to pronounce as vascular sinuses." ('Annals and Mag. of Nat. Hist.' vol. xix, p. 46, 1837.)




*Productus giganteus* (from Mr. Woodward's drawings).

*A.* Interior of dorsal valve. *B.* Interior of ventral valve, with the umbo removed. *C.* Ideal section of both valves. *D.* Hinge-line of dorsal valve. *J.* Cardinal process. *a.* Adductor. *r.* Cardinal muscles. *s.* Hollows occupied by spiral arms. *v.* Reniform impressions. *b.* Brachial processes. *h.* Hinge-area.

This view of Mr. Howse's relating to the interpretation of the reniform impressions is new, and would require some further investigation and confirmation before final admission, as it does not entirely agree with the notion entertained by Mr. Woodward, myself, and others, as to the probable form and position of the fleshy arms, which appear to have produced peculiar markings visible in the interior of both valves of several species of *Productus*; and in *P. giganteus* in particular, would appear to have been small, and vertically coiled. The singular markings seen in the larger valve (*s*) are no doubt imprints of those processes; and similar appearances are also visible in valves of *Strophomena rhomboidalis* and *Davidsonia Verneuilii*, where no reniform impressions exist.

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[1] This species seems to have been discovered independently by Mr. Howse and Professor King. Mr. Howse claims the adoption of his name on account of the two days' priority of publication.

PRODUCTUS UMBONILLATUS, *King*. A Catalogue of the Organic Remains of the Permian Rocks of Northumberland and Durham, p. 8, 19th of August, 1848; Monograph of English Permian Fossils, p. 92, pl. xi, figs. 14—18, 1850; *Anlosteges umbonillatus*, King, Annals and Mag. of Nat. Hist., vol. xvii, 2d series, pl. xii, fig. 6, March and April, 1856.

More or less sub-quadrate and concavo-convex, without articulating condyles; the larger valve is slightly convex, and rather flattened when young (fig. 1); more gibbous, and sometimes geniculated, when adult (fig. 4), with a shallow sinus commencing at about the middle of the valve, and extending to the frontal margin. The beak is not much inflated, nor is it produced beyond the extremity of the cardinal edge; the auricular expansions are hardly defined, the hinge-line being in general shorter than the greatest width of the shell; the margin is also more or less thickened, so as to simulate a false area, with a narrow uncovered fissure? The external surface of the valve is ornamented by a small number of irregularly scattered spines, which attain at times a considerable length. The dorsal or smaller valve is very slightly concave, with a small mesial wave.

In the interior of the ventral valve the muscular impressions occupy a pyriform space at the bottom of the valve; those produced by the adductor are oval, narrow, and placed on a mesial elevation; on either side of these are seen the longitudinally striated sub-quadrate impressions left by the cardinal muscle. In the interior of the dorsal valve the hinge-line margin is more or less flattened (figs. 9 and 10); the cardinal process, which projects at almost right angles to the plane of the valve, is bifid, with a deep slit or groove along the upper surface of each lobe. Under this a narrow longitudinal ridge extends to nearly two thirds of the length of the valve, and on either side are seen the scars produced by the adductor and reniform impression (figs. 5, 6). The remaining unoccupied surface of the interior is minutely pitted on the posterior half, and covered with produced tubercles on the anterior portion, and especially in the vicinity of the frontal margin.

The largest British examples I have seen measured 12 lines in length by 16 in breadth, but the shell is in general of smaller dimensions.

This species is well distinguished from *Productus horridus* by its external and internal details, as will be at once perceived from a comparison of the illustrative series of figures given in my Pl. IV, and which were drawn from the best examples hitherto discovered by Mr. Kirkby in the shell limestone of Tunstall hill, and by Mr. Howse in that of Dalton-le-Dale, Durham.[1] Specimens in which the shell is preserved appear rare; but beautifully perfect internal casts are rather more abundant, and upon them, in relief, may be studied

[1] Mr. Howse observes, that "it differs from its congener in several important particulars. The boss or muscular fulcrum, the shape of the muscular impressions, the greater size of the oral arms" (Mr. Howse alludes here to the reniform impressions), "the absence of cardinal spines on the upper valve, the flanging of the hinge-margin of the upper valve, are so strongly characterised, that it cannot be mistaken for any other species."

all the peculiarities of its internal organization (figs. 5 and 11). Although correctly described in 1848 and subsequently, it has nowhere been properly illustrated, for Professor King's figures were evidently taken from very imperfect material. The species was also discovered at Pössneck, in Germany, by Baron Schauroth, who published some illustrations of it in his first 'Beitrage.'[1]

Professor King is of opinion that the shell under description should be referred to General Helmersen's *Aulosteges*,[2] on account of the rudimentary area visible in some examples, but this appearance seems to be more deceptive than real in the greater number of specimens; nor have I any grounds to suppose that the narrow fissure observable in some specimens was covered by a deltidium, and the internal details, although slightly different, are essentially the same as those peculiar to *Productus;* and Professor King seems to be somewhat imbued with the same opinion, since he states, in his paper in the 'Annals' (1856), "I have represented the interior of the small valve of (?) *Aulosteges umbonillatus*, on which it will be seen these structures (the reniform impressions) are situated as in *Productus*."

### *Sub-Genus*—Strophalosia, *King*.

(Introduction, Vol. I, p. 115, 1853.)

The identification or fixing of the species to which our English *Strophalosias* should belong has given rise to considerable difference of opinion. I have therefore used every effort in my power, in the hopes of arriving at a satisfactory conclusion, by a prolonged examination not only of a vast number of specimens of our British and foreign equivalents, but also by a direct correspondence and discussion with those who have studied the subject with most attention.[3]

It must, however, be confessed that I have experienced considerable uncertainty and difficulty in arriving at a conclusion relative to some of the points upon which the difference of opinion principally prevails, and would therefore invite the reader to satisfy himself before adopting the suggestions here proposed. Some authors would divide the

[1] 'Ein Beitrag zur Fauna des Deutschen Zechsteingebirges,' 1853.

[2] Professor King considers the sub-genus *Aulosteges* to be represented by the following species: *A. Wangenheimi*, Vern. and Keyserling, sp., *P. umbonillatus*, King, and *Strophalosia tholus*, Keyserling (in Schrenk's 'Reise durch die Tundren der Samojeden,' vol. ii, p. 103, p. ii, figs. 18—21, 1854.

[3] The authors whom I have particularly consulted are Professor King, Mr. Howse, Mr. Kirkby, Count A. Von Keyserling, Professor L. de Koninck, Dr. Geinitz, and Baron Schauroth; but it has been impossible to arrive at a unanimous conclusion, probably from the different manner in which a species is viewed, some considering certain differences of specific value, while others view the same as accidental, or at most varietal.

English *Strophalosias* at present known into four or five species,[1] while others would feel disposed to admit but two or three. Assuming, therefore, that the *Strophalosias* in question belong but to two species, and that these are properly identified as the *Strophalosia Goldfussi*, Münster, and *S. lamellosa*, Geinitz, there exists, in my opinion, two or three varieties deserving a special notice, as well as a varietal designation. I have therefore described these separately, and given the different opinions entertained, in order that the reader may have a better opportunity of judging for himself as to the grounds upon which a larger number of species have been maintained, as the subject may still afford grounds for further discussion.

STROPHALOSIA GOLDFUSSI, *Münster*. Plate III, figs. 1—10.

SPONDYLUS GOLDFUSSI, *Münster*. Beitrage, vol. i, p. 43, pl. iv, fig. 3 *a*, *b*, 1839.
ORTHIS EXCAVATA, *Geinitz*. Neues Jahrback for 1842, pl. x, p. 578, figs. 13, 14.
PRODUCTUS GOLDFUSSI, *De Koninck*. Monographe du genre Productus, p. 148, pl. xi, fig. 4; and pl. xv, fig. 4, 1846.
ORTHOTRIX GOLDFUSSI, *Geinitz*. Versteinerungen, pl. v, figs. 27, 28, April, 1848.
STROPHALOSIA GOLDFUSSI, *King*. Monograph, p. 96, pl. xii, figs. 1—12, and 23? 1850.
— PARVA? *King*. Mon., p. 102, pl. xii, fig. 33, 1850.
— GOLDFUSSI, *Howse*. Annals and Mag. of Nat. Hist., vol. xix, 2d series, p. 47, 1857.

Very variable in its external shape, generally more or less sub-triangular (figs. 5, 7), subquadrate (fig. 6) or oval, but less commonly circular; its anterior angles are rounded,[2] and at times slightly indented in front. The hinge-line is always much shorter than the width of the shell; the beak of the larger valve tapering a little, and often twisted more to the one than to the other side; area narrow (figs. 1, 6, 14), with the extremity of the beak slightly protruding beyond its extremity, or large, triangular, and more or less bent backwards (figs. 3, 5, 8), varying both in height and breadth, with a narrow fissure covered by a

[1] Professor King writes me on the 29th of July, 1857—"My present view of Permian North of England *Strophalosias* is, that there are the following species: *S. excavata*, *S. Goldfussi*, *S. Humbletonensis*, *S. Morrisiana*, and (?) *S. parva*. I doubt much that *Orthotrix lamellosa* and *Cancrini* of Geinitz and Germany are the same as my *Morrisiana* and *Humbletonensis*. The *lamellosa* does not appear to occur in the North of England."

[2] Professor King alludes to the great variability presented by the different individuals composing the present species. At p. 97 of his Monograph he also mentions that the casts so abundant at Ryhope-field House differ from those found at Humbleton hill, in having the larger valve more rounded, with a very small indication in some specimens of a median furrow. This fact has also been confirmed by Messrs. Howse and Kirkby, who have assembled a vast number of specimens from both localities. The length of the hinge-line is often not more than one third of the breadth of the shell. There appears also to exist every passage from those examples which are longer or shorter than wide to those which are almost circular; some are irregularly and scantily spined, while others have the spines closely and regularly placed.

convex pseudo-deltidium. There is also a small area in the dorsal valve. The ventral or dental valve is moderately convex, with or without a shallow mesial furrow or sinus; the dorsal or socket one being moderately concave, and following the curves of the opposite valve, that is to say, with or without a slight mesial elevation corresponding with the sinus in the ventral valve. Externally the whole surface (areas excepted) is covered with a multitude of curved slender tubular spines, which attain a considerable length, and are irregularly placed at not much more than their thickness one from the other (fig. 13). These spines in the larger valve lie, from their origin, either close to the surface, or vertically implanted, become suddenly bent downwards so as to become entangled one with the other;[1] but those on the smaller valve seem in general to converge towards the centre of the shell,[2] the valves being likewise marked by numerous incremental lines or wrinkles of growth. When quite young the shell is much depressed, the smaller valve being almost flat and circular, while the umbone is comparatively produced. *Strophalosia Goldfussi* varies also in proportions, but does not often exceed 1 inch in length, and somewhat less in width; but when covered with its spinulose appendages, presented larger proportions.

In the interior of the larger valve a tooth is situated on each side at the base of the deltidium, which articulates by the means of sockets placed on both sides of a cardinal process in the opposite valve (fig. 12); and at a small distance from the extremity of the beak there is a short, raised, slightly curved platform, with a somewhat obtuse abrupt termination towards the centre of the valve. On this are placed the two small oval scars produced by the adductor, and separated by a minutely elevated line or ridge (fig. 14), better seen in hollow or on internal casts (figs. 10 and 13 A). Immediately under, but outside, there are two longitudinal, slightly indented, and sub-quadrate semicircular impressions, produced by the cardinal muscle (fig. 10[3]), and which seem to have been

[1] M. De Koninck observes that sometimes the spines, while interlacing each other, surround foreign objects which may lie within their reach, and that those situated on the beak appear to have possessed that faculty in particular. He possesses specimens of which the spines envelop the fragment of a large spine of *Productus horridus*, and Dr. Geinitz has figured another similar example.

Mr. Howse informs me that the typical German *Goldfussi* from the Zechstein differ somewhat from those we are accustomed to call *Goldfussi* in England. They are shapeless at first until well cleaned, like Münster's figure, and somewhat more circular, and densely covered with very curved spines. They occur in little marly nodules, out of which they are washed with a tooth-brush into very fine specimens.

[2] At least such is seen to be the case in many German specimens, and has been so described by Professor De Koninck in his 'Monographie du genre Productus.' A beautiful illustration by M. Suess will be found in pl. v, fig. 10 *b*, of the German edition of my General Introduction.

[3] The remarkable internal cast, of which I offer an enlarged illustration in Pl. III, figs. 9, 10, was discovered by myself at Humbleton quarry, during a visit to that locality in company of Messrs. Howse and Kirkby, and it is worthy of remark that, although those gentlemen and Professor King have collected some hundred of specimens in the same and in other localities, as well as by Baron Schauroth in the Zechstein Dolomit of Pössneck, in Germany, in none were these scars so well or so distinctly displayed as in the specimen here represented, and which I had already figured and described in my few notes on Permian genera, published in vol. ii of the 'Bulletin de la Société Linneenne de Normandie,' Feb., 1857.

overlooked or unobserved by those who have described the interior of this species, as they are not represented in any of their illustrations. These impressions are also much less deeply marked in *Strophalosia* than in *Productus*, but prove that they were in general character essentially similar to those of that genus, varying only to a small extent in shape and depth.[1] The position of the adductor in this valve has been noted by several writers, and is represented in pl. xii, fig. 3, of Professor King's 'Monograph;' but the author describes them "as the cardinal and valvular muscular scars confluent," which appears to be a mistaken view from the evidence afforded by my specimen, in which both are distinctly separated, as in *Productus*.

In the interior of the smaller or dorsal valve the cardinal process is of moderate dimensions, but considerably developed and produced in certain individuals (figs. 12, 16, 17), from the base of each of which proceed three strong ridges, viz., a median longitudinal one, which extends to about half the length of the valve, and two short lateral ones, which constitute the inner socket-walls. On either side of the median ridge or septum there are two small longitudinally divided pear-shaped impressions, produced by the adductor, the one close to the central ridge being the largest (figs. 8 and 12 A). The reniform impressions are large, their prominent outer edge issuing from between the adductor scars, gradually arch forwards and outwards on each side, then turning backwards for about half their length, and finally run inwards horizontally to meet each other near the extremity of the median septum or ridge. The interior surface of this valve is either uniformly convex, or presents a small medial depression or sinus towards the front (fig. 12), while in a few young individuals there is a raised margin, somewhat similar to that seen in different forms of *Thecidium*, and of some other Brachiopoda (fig. 17[2]). The internal surface is also minutely pitted all over, with the exception of those parts occupied by the muscular scars.

*Strophalosia Goldfussi* is stated by Professor King and Mr. Howse to have been found in the compact and shell limestone of Humbleton and Tunstall hills, Clack's Heugh, Ryhope-field House, Dalton-le-Dale, Garmundsway, Castle-Eden Dene, and in the Breccia of Tynemouth.

On the Continent it seems equally common. Count Münster's original example was obtained from the lower Zechstein of Röpsen, near Gera. Dr. Geinitz mentions Milbitz,

[1] The muscles were, perhaps, stronger and more deeply implanted in *Productus*, to supply the deficiency of the articulated hinge which *Strophalosia* possesses. The cardinal process appears to be also rather larger in *Productus* than in the last-named genus. Mr. Howse observes, that "the boss or cardinal muscular fulcrum (in *Productus*) when *in situ*, fills nearly the whole of the umbonal cavity of the lower valve, and presses against its inner surface; it may thus assist in keeping the valves in position."

[2] I have been able to study this curious peculiarity in four or five examples from Tunstall hill, in the collection of Mr. Howse. They consist of beautifully preserved detached valves of young individuals, not exceeding three and a half lines in length; but in all the larger individuals which have come under my observation, the raised margin has either entirely disappeared, or exists only in a very obscure and rudimentary condition.

Corbusen, &c. Baron Schauroth has found it abundantly in the Zechstein dolomit of Pössneck, where it appears associated with the same species found at Humbleton and in some other of our magnesian shell limestone localities.

In 1839 Münster figured, under the name of *Spondylus Goldfussi*, a specimen evidently belonging to the shell under description. It is longer than wide, concavo-convex, and covered with spines; but as much of the beak and area was obscured by matrix, the German author was not quite certain as to the exact place his shell should occupy; so that, while placing it in *Spondylus*, he at the same time took care to add, that had it been free he should have taken it for a *Productus*. The shell under description is the one very generally known on the Continent to represent the species of the German Count, which either did or did not possess a mesial furrow in the larger valve, so that this last-named feature could not be considered as a character of any specific importance.

In 1842, Dr. Geinitz described and figured a small shell under the name of *Orthis excavata*.[1] It was longer than wide, with a straight and large triangular area, narrow fissure, pointed beak, and plano-convex spinulose valves. This shell has appeared to me, as well as to Professor De Koninck and Mr. Howse, to be only a young condition of *Strophalosia Goldfussi*, and in our opinion should therefore be placed among the synonyms of that species; but Professor King dissents from this view, and seems disposed to consider it not only a distinct species, but also the same as that subsequently named *Prod. Lewisiana* by Professor De Koninck, 1846. At a later period, in 1848, it is true Dr. Geinitz published figures of his so-termed *excavata*, differing somewhat from the original type, and which might be either taken for *S. Goldfussi* or its variety *S. Lewisiana*, and from this unfortunate coincidence much of the confusion and uncertainty has arisen that prevails at present among these Strophalosias.

I therefore consider it necessary to restrict my inferences upon this matter to the

[1] In the 'Neues Jahrbuch' for 1842, p. 578, figs. 12 and 13 *a*, *b*, Dr. Geinitz has omitted to represent the tubercular prominences left by the broken spines, so that his figures might give the idea of a smooth species; but in the accompanying description the author does not omit to allude to their existence. Professor King kindly forwarded for my examination three or four examples closely agreeing with Geinitz's figure, and which he had obtained when in Germany; but after a minute examination of these (evidently young shells) with fig. 3 of my Pl. III, which certainly belong to Münster's species, I could perceive no differences of sufficient importance to warrant my supposing them specifically distinct. In a letter written by Dr. Geinitz to Professor King, dated the 11th of March, 1857, the German author states that *Stroph. Goldfussi* "*is without sinus*," which observation cannot be considered strictly correct, for although it may not be perceptible on certain individuals, it exists to a greater or lesser degree on the larger number. Dr. Geinitz also mentions that his *Orthis excavata* of 1842 is the same as the one described under the name of *Lewisiana* in 1846, and by Professor King under that of *Stroph. excavata* in 1850; but I fear I must object to that interpretation. Dr. Geinitz further observes that *Stroph. excavata* possesses "*a sinus more or less only in the upper Zechstein*," but his figures of *O. excavata* show none; and in the character published in 1842, he distinctly states that the larger valve is regularly convex, and that the smaller one is similarly concave, and there is no mention of any sinus.

original representations published in 1839 and 1842, and finding these to belong to the same species, it appears to me desirable, in order to obviate further confusion, to erase the term *excavata* altogether; and if the shell described as *St. excavata* by King (figs. 19—22 of my plate) is to be either viewed in the light of a separate species or variety of *Goldfussi*, the term *Lewisiana*, De Koninck, is the one which should be adopted. So little is known of the shell termed *Strophalosia parva*, King,[1] that I should not consider myself justified in admitting it as a distinct or well made out species, and have therefore followed Professor M'Coy and Mr. Howse in leaving it, provisionally, among the synonyms of *St. Goldfussi*, which it appears to resemble; for the specimen in the Museum of Practical Geology (fig. 18) proves that it was not always "irregularly circular marginally," as stated by Professor King, since the individual before us is sub-trigonal, as is the case with the larger number of *St. Goldfussi*. It has also been ascertained that the spines in Münster's species very often attain the comparative length displayed in King's illustration, as well as in the one I have represented.

*Var.* Lewisiana, *De Koninck*. Plate III, figs. 19—22.

Productus Lewisianus, *De Koninck*. Monographie du genre Productus, p. 150, pl. xv, fig. 5, 1846.

Orthotrix excavatus, part, *Geinitz*. Versteinerunger, pl. v, fig. 38; pl. vi, figs. 20, 21, 1848.

Productus spiniferus, *King*. Catalogue of the Organic Remains of the Permian Rocks of Durham, &c., p. 8, 1848.

Strophalosia excavata, *King*. Monograph, pl. xii, figs. 13—17, 1850.

Almost circular or slightly transversely oval marginally, and about as wide as long, regularly concavo-convex: hinge-line shorter than the width of the shell, with a narrow area in both valves, that of the larger one possessing a small fissure, covered by a pseudo-deltidium. The ventral valve is generally uniformly convex, but in some examples presents a narrow, very slightly marked, median depression on the anterior portion of the valve. The beak is regularly rounded, incurved, and varying in its proportions: the smaller valve is concave, following the curves of the opposite one. Externally the entire surface of the valves is covered with a vast number of long, slender, tubular spines, which are situated sometimes very uniformly in quincunx, but in the larger number of individuals this extreme regularity does not appear to exist. The internal details are exactly similar to those of the typical *Goldfussi*. In dimensions this variety does not in general exceed 10 lines in length, by about the same in width.

Professor De Koninck, Dr. Geinitz, and Professor King consider the shell under

[1] King's 'Monograph,' pl. xii, fig. 33, 1850.

description to be specifically distinct from *St. Goldfussi;* and Baron Schauroth informs me that he is also of opinion that, although *Strophalosia Lewisiana* and *St. Goldfussi* are closely related, the first can always be distinguished by its more circular shape, as well as by its lower and smaller area. Messrs. Howse and Kirkby, on the contrary, state that, after the careful study of this form, they cannot find one fixed character by which to distinguish the shell we are now describing; that the two extreme forms I represent (Pl. III, figs. 3 and 19—22) graduate by almost imperceptible degrees into each other, having in the regular form a narrow area and incurved beak, and in the other a larger area and a depressed beak. I have therefore considered the shell under description as a variety of *Goldfussi*, with the denomination of *Lewisiana*, so that it may be thus retained, or specifically separated, should such a course be considered desirable.[1]

In a paper published in the 'Annals of Natural History' for March and April, 1856, Professor King has proposed to consider the shell (fig. 23 of our Pl. III) as a variety of *Strophalosia excavata*, to which he has applied the varietal term *Whitleyensis*, but from such imperfect and insufficient material as the cast of a single dorsal valve, we can decide with but little certainty; it may or not belong to *Stroph. Goldfussi* or its var. *Lewisiana*.

The variety *Lewisiana* has been found in the same beds and localities already recorded for *Stroph. Goldfussi*, both in this country as well as on the Continent, but is not so abundant as the typical form of Münster's species.

STROPHALOSIA LAMELLOSA, *Geinitz*. Plate III, figs. 24—41.

ORTHOTRIX LAMELLOSUS, *Geinitz*. Versteinerungen, p. 14, pl. v, figs. 16—26, April, 1848.

STREPHALOSIA MORRISIANA, *King*. Catalogue of the Organic Remains of the Permian Rocks of Northumberland and Durham, p. 9, 19th of August, 1848; Monograph of English Permian Fossils, p. 99, pl. xii, figs. 18—25, and 27—32; Annals and Mag. of Nat. Hist., vol. xvii, 2d series, March and April, 1846.

LEPTÆNA CANCRINI, *M'Coy*. British Palæozoic Fossils, p. 457, 1855 (not *Productus Cancrini*, Verneuil and Keyserling).

[1] It has been argued that the regular form of a shell should be taken as the type of the species, and not the irregular growth, and I quite coincide in the opinion; but when we view a species under its general aspect, and find that the great majority of individuals of which it is composed are not perfectly regular, the beak being more often twisted a little to the one side or to the other, and that the shell is more often sub-trigonal, and rarely circular as in *Stroph. Goldfussi*, with or without a slight mesial elevation in the smaller valve, and corresponding depression or sinus in the opposite one, we feel bound to select our typical shape from the normal condition, or the one that gives the best representation of the general character of the species, and not only from one particularly favoured individual who may have been perfectly symmetrical in all its parts.

STROPHALOSIA MORRISIANA, *Schauroth.* Ein neuer Beitrag zur Palæontologie des deutschen Zechsteingebirges, p. 221, 1856.

— CANCRINI, *Howse.* Annals and Mag. of Nat. Hist., vol. xix, 2d series, p. 49, 1857 (not *Productus Cancrini*, Verneuil and Keyserling).

Shell nearly circular, or slightly oval marginally when full grown: concavo-convex, and in general about as wide as long, the greatest breadth being situated towards the middle or anterior portion of the shell. The ventral or larger valve varies much in degree of convexity. It is evenly convex and without sinus in well-shaped individuals, while in others the greatest gibbosity is situated towards the beak. The margin of the valve is likewise sometimes either slightly bent upwards, or suddenly downwards, while in other specimens the convexity is very moderate. The beak is regularly shaped, evenly rounded and incurved in the larger number of full-grown specimens from certain localities (fig. 35), showing no indication whatever of having adhered by any portion of its surface (var. *Humbletonensis*, King); but other examples less favorably placed or developed in the same and in other localities, show that the shell adhered or was adpressed to a greater or lesser extent (fig. 25); and this is particularly the case with distorted shells (figs. 28—30), where the beak is truncated, and more or less irregular in shape and growth (*Stroph. lamellosa*, type, and var. *Morrisiana*, King). The hinge-line is much shorter than the width of the shell; the area in the larger valve is narrow, and sometimes hardly visible in those shells which possess an evenly rounded and incurved beak. It is also in such cases linear and scarcely perceptible in the opposite valve, but becomes larger and better developed in both valves in those less-perfectly shaped individuals, in which the beak adhered to some foreign body, or did not extend beyond the cardinal edge (figs. 25 and 31). The external surface of the large valve is ornamented at variable intervals by long, adpressed, tubular, creeping spines, directed outwardly and downwardly, and often adpressed for a distance of eight or nine lines before rising from the surface of the valve (figs. 34 and 36), so that, when perfect, some of the spines must have exceeded an inch in length; but those on the lateral portions of the beak and cardinal edge stand erect from their origin, or are slightly directed backwards. The surface of the valve is also more or less distinctly covered by a multitude of minute, radiating, raised striæ, which increase in number by intercalation and bifurcation (figs. 40, 41), and are sometimes so closely packed, that towards the middle of a specimen measuring one inch in diameter, from eighteen to twenty may at times be counted in the space occupied by a couple of lines (fig. 40): they are also more or less irregular in their respective widths, and at times, by the uniting of two or three, form the base of a spine (fig. 41).

The dorsal valve is, in general, moderately or very slightly concave, and almost flat, in very young shells, with a slight convexity at the umbone. The external surface also presents numerous radiating striæ, with small indented impressions at various intervals (fig. 35). In the generality of specimens no spines existed on this valve, but that some

few short ones occasionally occurred seems demonstrated from their presence in a certain number of specimens recently discovered at Ryhope by Mr. Kirkby (fig. 42). Numerous lines, laminæ, or wrinkles of growth, occasionally occur on the surface of both valves, and particularly so in specimens from certain localities in the lower Zechstein, where the shell assumed dwarfish dimensions, and lived under different conditions to those that existed during the deposition of the upper shell limestone.[1]

Interiorly the valves articulate by means of teeth and sockets; and as the muscular and reniform impressions agree in arrangement and character with those of *St. Goldfussi*, already described, they need not be again reproduced (figs. 37 and 39).

In dimensions this species does not often appear to exceed 15 or 16 lines in length, by about the same in breadth, the greatest depth between the valves rarely exceeding 6 lines.

Considerable difference of opinion has been expressed regarding the shells here classed under *Orthotrix lamellosus*, of Geinitz, a species founded on a dwarf race, of which *Strophalosia Morrisiana*, var. *Humbletonensis*, may be considered the full grown and most favoured form. Geinitz's shell (of which I have seen several typical examples, found near Gera by Mr. Howse, as well as others from Moderwitz, &c., forwarded by Baron Schauroth) never appears to have greatly exceeded 7 or 8 lines in length and breadth; and they also very often exhibit indications of having adhered by portions of their beak, but otherwise possess all the essential or important characters of the more favoured varieties, for their larger valve is sparingly covered with long adpressed spines, and more or less distinctly marked radiating striæ. The smaller valve also is generally spineless, but striated as in the more perfect shells; but in this dwarf race or condition the surfaces of both valves seems more closely marked with larger and more prominent incremental lines, or laminose projections, than in the var. *Humbletonensis*, King. While describing his *Strophalosia Morrisiana*, in p. 100 of the 'Monograph of English Permian Fossils,' Professor King places *Orthotrix lamellosus* with a point of doubt among the synonyms of his species, and adds—"In making the *Orthotrix lamellosus* of Geinitz synonymous with this species, notwithstanding the former is stated to be without spines on the small valve, I have been influenced by certain of my specimens displaying lamella on this valve, somewhat similar to those represented in the 'Versteinerungen,' at figs. 15 *a*, 16, 17 *a*, 21, pl. v. The fossils identified by Dr. Geinitz (*vide* pl. vi, figs. 16—18) with the *Stroph.*

[1] It may be remembered that Professor King, in p. 101 of his 'Monograph,' has alluded to a singular peculiarity presented by some examples found at Humbleton hill, of appearing possessed of three valves, a circumstance he feels at a loss to account for satisfactorily. Mr. Howse (in his paper published in the 'Annals' for 1857) remarks, "there is also a tendency in this species to form a new internal surface behind the old upper valve, for the purpose of contracting the interior of the shell. It is not an additional third valve as King has supposed, for it is essentially connected with the upper valve, and must have been formed by the upper lobe of the mantle." I have seen several examples presenting this peculiarity, but it is only of rare occurrence, and is therefore not a general character of the species.

*Cancrini*, I readily recognize as belonging to *S. Morrisiana*." Again, in his paper in the 'Annals' for March and April, 1856, Professor King observes—"I suspect all the specimens described and figured by Geinitz as *Orthotrix lamellosus* and *Prod. Cancrini* belong to var. *Humbletonensis*." From the above it is evident that Professor King suspected *Stroph. Morrisiana* and *lamellosus* to be synonymous, but from not being cognizant with Geinitz's priority, had placed the German author's name among the synonyms of his own. Baron Schauroth, in his late publication, considers *S. lamellosa* a variety of *Morrisiana;* and Mr. Howse is now strongly convinced that the two are synonymous.

*Strophalosia Morrisiana* has been several times confounded with *Productus Cancrini*, a shell not only specifically but generically distinct. In 1855, Professor M'Coy felt confident as to King's species being a synonym of *Cancrini*, which opinion was also reproduced in January, 1847, by Mr. Howse; and Professor De Koninck was strongly biassed towards a similar conclusion. Professor King, on the contrary, has always maintained that both were distinct although closely related species.

In order to arrive at a positive conclusion, I obtained from Dr. Schrenk, through the mediation of Count A. von Keyserling, a perfect example of the Russian *P. Cancrini*, brought from Usty Joshuga, near Archangel (see woodcut in p. 48), and for which kindness I feel much indebted to my two Russian friends. On its arrival in England, I lost no time in submitting the specimen to the attentive examination of Professor King, Mr. Howse, and Mr. Kirkby, and they all agreed with me that it was a true *Productus*, while Geinitz's *lamellosus* and King's *Morrisiana* belonged to the genus *Strophalosia*, these shells differing in every particular except in that of the striæ, a character that appears to have been the source of all the mistaken identifications.

*Productus Cancrini* may be at once distinguished from all the varieties of *Strophalosia lamellosa* by its total absence of area and denticulated hinge;[1] for although the first is small and scarcely perceptible, on account of the incurvation of the beak, in the larger number of *Strophalosia lamellosa*, var. *Humbletonensis*, it is clearly visible; the hinge-line, which in the last is comparatively much shorter, is also distinctly articulated by the means of teeth and sockets; it differs also in general character, the spines on the back of the larger valve in *P. Cancrini* do not appear to have been so long, adpressed, or creeping, as in *St. lamellosa* and its varieties, and the numerous erect cardinal spines are altogether

[1] In order to facilitate comparison, I have here described the Russian example of *Productus Cancrini*, kindly forwarded by Dr. Schrenk and Count Keyserling:

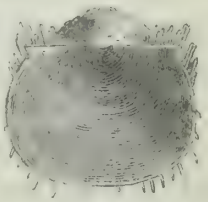
*Productus Cancrini*, Murch. De Verneuil and De Keyserling, Russsia and the Oural Mountains, vol. ii, p. 273, pl. xvi, fig. 8 *a*, *b*; pl. xviii, fig. 7, 1845.

— — De Koninck. Monographie du genre Productus, p. 105, pl. xi, fig. 3, 1847.

Shell concavo-convex, as wide as long, slightly transverse or elongated, and rarely exceeding one inch

peculiar. Its relationship to more than one Carboniferous species has also been noticed both by M. De Verneuil, De Koninck, and others.

There exists, perhaps, one or two varieties of Geinitz's *Stroph. lamellosa*, which it might be desirable to distinguish by varietal appellations;[1] but it would be incorrect to



(The radiating striæ have not been sufficiently expressed in this cut.)

in length, by about the same in width. The larger or ventral valve is very convex and swollen out posteriorly, without any mesial depression or furrow; the lateral slopes are rapid, and almost perpendicular to the back of the valve. The beak is of moderate dimensions, rounded, and projecting but very slightly beyond the cardinal edge. The hinge-line is straight, and a little shorter than the greatest width of the shell, without area or hinge-teeth. The ear-shaped expansions are small, and terminated by a peculiar angular plait. The outer surface of the larger valve is covered by a great number of minute, irregular-sized striæ, which are simple or dichotomous, one, two, or more forming the elongated base of a spine; these last are irregularly scattered over all the surface, at variable distances; those on the back are more sparingly distributed than on the ears, and project somewhat outwardly and downwardly; but those on the lateral slopes are perpendicular to the striæ. The spines on the cardinal region and ears are quite erect, long, and so numerous that they completely conceal the surface of the shell. The length attained by the spines on different portions of the valve is very variable; some are of great length, hollow, and ornamented by delicate rings. The smaller or dorsal valve is concave, following the curves of the opposite one; no area nor hinge-sockets are visible; the surface is covered by a multitude of fine, slightly raised, radiating striæ, and numerous wrinkles or lines of growth. This *Productus* was well described by M. De Verneuil and Count Keyserling, as also by M. De Koninck, from the Permian beds of Russia. The first two authors discovered it at Kicherma, on the river Wel; and Ouchta, at Chidrova, Arramas Ilschalki, Kidash Nikefur, Grebeni, &c. Dr. Schrenk found it at Ustj-joshuga, near Pinega, in the Government of Archangel. Baron Schauroth obtained the same shell at Milbitz, in Germany; and Professor De Koninck describes the species from Bell Sound, Spitzberg; but it has not hitherto been discovered in our British Permian strata.

[1] In a very interesting paper published in the 'Annals and Mag. of Nat. Hist.' for March and April, 1856, Professor King describes his two varieties as follows:

"*Strophalosia Morrisiana*, taking the Tunstall hill specimen as its type, may be described as follows: *General form* flatly concavo-convex, transversely elliptical. *Large valve* slightly convex, evenly rounded, often with one or more contracted longitudinal furrows; wrinkles on the sides, and furnished with a number of long, rather distant, somewhat irregularly arranged creeping or adpressed spines directed forwards; both inner and outer surface marked with nearly obsolete striæ, radiating from the umbone; also with numerous well-defined incremental lines. *Umbone* slightly affecting the even roundness of the valve; decidedly impressed or truncated, and scarcely converging down to the cardinal edge. *Area* a little more in length than half the width of the valve; rather low, but well defined, being in the form of a very obtuse triangle, the sides of which are about equal to $\frac{2}{3}$ths of the length of the base; faintly lineated transversely, and furnished with a narrow deltidium. *Small valve* slightly concave, here and there exhibiting a few nearly obsolete, slightly elongated, indented impressions, a little raised at their anterior end, which causes them to appear as if produced by a blunt-pointed instrument; both inner and outer surface marked with fine radiating striæ, a little more strongly marked than those on the large valve. *Nucleus* raised a little above the general surface of the valve; area little more than rudimentary. All the specimens I collected of this species are a little under an inch in width, and about $\frac{3}{4}$ths of an inch in length. The smaller valve, I am strongly inclined to think, cannot be considered spiriferous; probably the nearly obsolete indented

suppose that the typical shape of *lamellosa* does not occur in England, as examples identical with some represented in Geinitz's Versteinerungen have been found at Dalton.[1]

*Loc.* *Strophalosia lamellosa* or *Morrisiana* has been found by Professor King, Messrs. Howse, Kirkby, and others, in the shell and compact limestone of Humbleton and Tunstall hills, Ryhope-field House, Weston, Dalton-le-Dale, Clack's Heugh, &c. A very remarkable specimen has also been found by a gentleman in the lowest beds of limestone at Midderidge. The species likewise occurs in several German localities near Gera, at Pössneck, &c.

## *Family*—CRANIADÆ.

### *Genus*—CRANIA.

(*Vide* Introduction, Vol. I, p. 122.)

CRANIA KIRKBYI, *Davidson.*

The upper valve only of this shell has been discovered. It is sub-quadrate, with rounded angles, and is sometimes a little indented at its anterior margin: is slightly conical, with a sub-central vertex, and presents a small longitudinal depression on its anterior portion. Externally the entire surface is closely covered by a multitude of minute, short, hollow, spinulose tubercles, which produce a granulated aspect. The interior was not completely exposed in the specimens; but the

impressions may be modified bases of abortive spines. I am not aware that this species has been found anywhere except at Tunstall hill. * * * * * *

"Var. *Humbletonensis.* *General form* rather strongly convex, as wide as long, sometimes longer than wide, rarely the converse. Large valve rather strongly convex, and evenly rounded; occasionally with one or more longitudinal wrinkles on the sides; furnished with numerous long, somewhat irregularly arranged spines, creeping, and directed forward on the back, erect, and bent backwards on the sides and adjacent to the hinge; both inner and (?) outer surface marked with numerous fine striæ, radiating from the umbone, also with well-defined incremental lines; umbone somewhat tumid, occasionally a little impressed, and incurving over or below the cardinal edge; area small, scarcely perceptible through the incurvation of the umbone; teeth well developed. *Small valve* slightly concave, marked with numerous elongated, indented impressions, which are somewhat regularly arranged, and deepest at their anterior end; both inner and outer surface marked with distinct radiating striæ; those on the sides near the hinge dichotomous, and arcuated or curving posteriorly; they pass uninterruptedly over the indented impressions, and are crossed by rather strong incremental lines. *Nucleus* raised a little above the general surface of the valve."

[1] Dr. Geinitz has also declared (in a letter to Professor King, dated Dresden, the 11th of March, 1857) that his *St. lamellosa* is distinct from King's *Morrisiana*, but he has also confounded this last with *Productus Cancrini*, and is evidently not well acquainted with the numerous forms and variations presented by his *lamellosa* in England.

two posterior muscular impressions were perfectly displayed, while the anterior or central ones were much concealed by the matrix. The dimensions of the largest example were —length 4, breadth $5\frac{1}{2}$ lines.

About fifteen examples of this interesting species were discovered by Mr. Kirkby in the shell limestone of Tunstall hill. In external form it bears much resemblance to many species of *Cranium;* but the peculiar spinulose character, combined with its sub-quadrate shape, distinguishes it from those species to which it bears the nearest affinity. This is also the first time that a *Cranium* has been recorded from the Permian rocks, a discovery entirely due to the active researches of Mr. James Kirkby, to whom I take the greatest pleasure in dedicating the species.

## *Family*—DISCINIDÆ.

(*Vide* General Introduction, Vol. I, p. 126.)

### Discini Koninckii, *Geinitz.* Plate IV, figs. 27—29.

Orbicula Koninckii, *Geinitz.* Grundriss. d. Verst., p. 495; and Versteinerungen, pl. iv, figs. 25, 26, April, 1848.
Discina speluncaria, *King.* Mon., pl. vi, figs. 28, 29.

Circular, or oval marginally; the upper valve conical, and of moderate elevation; the vertex sub-marginal, situated at a variable distance from the posterior margin. The lower valve is almost flat, with a fissure extending from the centre to nearly the edge of the shell. The valves are strongly marked by numerous concentric lines of growth. In dimensions it rarely exceeds 3 or 4 lines in length, by 3 or $3\frac{1}{2}$ in width.

*Discina Koninckii* appears to be one of the rarest of our British Permian fossils, as I have never seen more than five or six examples. It has been collected at Thrislington Gap, in the marl slate; at Garmundsway, in the overlying beds of compact limestone; in the shell limestone of Tunstall hill, by Professor King; and in the last-named locality, and at Humbleton hill, by both Messrs. Howse and Kirkby. On the Continent it appears also rare; and I am indebted to Baron Schauroth for examples from Ilmenau, in Germany.

The only authors who have hitherto described and figured the species are Dr. Geinitz and Professor King;[1] but I entirely coincide with Mr. Howse[2] and M. De Koninck,

[1] In the 'English Permian Fossils,' p. 85, Professor King makes use of the name *Discina speluncaria* in preference to that of *Koninckii.*

[2] 'Annals and Mag. of Nat Hist.,' vol. xix, 2d series, p. 44, 1857.

while adopting the term *Koninckii* in preference to the apocryphal one of *O. speluncaria*, simply mentioned in the German edition of Sir H. de la Beche's 'Manual' (1832).[1]

## *Family*—LINGULIDÆ.

(*Vide* Introduction, Vol. I, p. 133; and Appendix, p. 8.)

LINGULA CREDNERI, *Geinitz*. Plate IV, figs. 30, 31. (King's Monog., pl. vi, figs. 25—27.)

LINGULA CREDNERI, *Geinitz*. Versteinerungen des Zechsteingebirges, p. 11, pl. iv, figs. 23—29, April, 1848.

A small oval shell, rarely exceeding 5 lines in length, by $3\frac{1}{2}$ in width. The valves are very slightly convex, thin, and marked by numerous raised lines of growth.

This species has been well described by Dr. Geinitz, Professor King, and Mr. Howse. It is found in the marl slate of Ferry hill, Thrislington Gap, and Trickley. Mr. Howse possesses a bivalve example, in which the attenuated beak of the ventral valve is clearly exhibited. It may still remain a question to be determined hereafter, whether this form did not also occur in the Carboniferous period, for it is very difficult to separate several species of *Lingula*, which closely resemble each other. *L. Credneri* is not a rare fossil, either at Ilmenau or Corbusen, in Germany.

[1] It is a *Catalogue name*, which Goldfuss communicated to Von Decken for the German translation, and all that is said consists of "*Orbicula speluncaria*, Schlotheim, Glücksbrunn." But the name is nowhere to be found in any of Schlotheim's numerous Memoirs, and it is probable that Goldfuss took the denomination from Schlotheim's collection, and nothing warrants the assertion made that it is the same as that dedicated by Geinitz to M. De Koninck. It was mentioned by M. De Verneuil as "un corps tres douteux," in the 'Bulletin de la Société Geologique de France,' vol. i, 2d ser., p. 504, 1844, and might be a little *Patella*, or anything else than a *Discina*, for all we know; and therefore we feel in justice bound to adopt the name given by Geinitz, as the species was first described and illustrated by him. *Catalogue names* are so injurious to the progress of science, that their introduction cannot be too strongly deprecated, nor can they ever claim priority over any subsequent description or illustration of the same object by another author.

## PLATE I.

(Permian Species.)

Fig.

1. Terebratula punctata, *Sowerby.* } These specimens were figured in this place by mistake; they
2—4. Rhynchonella tetraedra, *Sow.* } belong to the Liassic period.

5. Terebratula elongata, *Schlotheim.* A large specimen. Humbleton hill. Collection of Mr. Kirkby.

6, 7. — — Two average-sized specimens. Tunstall hill.

8—11. — — var. *sufflata.* Different ages. Tunstall hill.

12—14. — — Young specimen. Tunstall hill.

15—17. — — var. *sufflata.* Casts. Humbleton. The letter N indicates the slit in the beak, due to the rostral plates.

18. — — A remarkable internal cast from Humbleton, formerly in the collection of Mr. Howse, now in that of the Museum of Practical Geology. The letter *a* refers to the curious impression explained in fig. 20.

19. — — A very fine interior, showing the rostral plates of the dorsal valve, and loop in the ventral one: enlarged from a specimen in the collection of Mr. Kirkby.

20. — — A beautiful fragment, considerably enlarged, from Humbleton. In the collection of Mr. Howse.

21, 22. — — Two interiors of the dorsal valve, to show small dissimilarities in the shape of the loop.

23. Spirifera alata, *Schlotheim.* Internal cast of a large example. Humbleton hill.

24. — — A trigonal specimen from Humbleton hill. Collection of Mr. Kirkby.

25. — — A testiferous specimen. Tunstall hill. Collection of Mr. Kirkby.

26, 27. — — Two specimens from Humbleton, showing the spirals. Collection of Mr. Kirkby.

28—31. — — Different specimens and ages from Humbleton and Tunstall hills. In the collection of Mr. Kirkby.

32. — — Portion of the internal cast of the dorsal valve (enlarged), to show the position of the adductor impressions, A A; also of the cardinal process. Collection of Mr. Howse.

33. — — A gutta-percha impression from specimen, fig. 32 (less enlarged), showing the interior of the valve itself.

35, 36. — — var. *Permiana*, King? Humbleton hill.

37. Spiriferina cristata, *Schlotheim.* Tunstall hill. Collection of Mr. Kirkby.

38, 39. — — Internal casts. Humbleton hill. N, slits left by the dental plates.

40. — — Interior (magnified), showing the spirals *in situ*, from a perfect specimen. Humbleton. Collection of Mr. Kirkby.

41. — multiplicata, *Sowerby.* (Enlarged.) Tunstall hill.

42. — — Interior of the ventral valve (enlarged), to show the position of the central septum and dental plates. Collection of Mr. Kirkby.

43. — — From Tunstall hill.

44. — — A remarkable example, with unusually developed area, from Tunstall hill. Museum of Practical Geology.

45, 46. — cristata? Young shells. Tunstall hill.

47—49. Spirifera Clannyana, *King.* (Enlarged.) Ryhope-field House.

PLATE I (*continued*).

Fig.

50. ATHYRIS PECTINIFERA, *J. de C. Sowerby*. Slightly enlarged. Humbleton hill. A portion of the spinose expansions have been removed on one side. Collection of Mr. Kirkby.

51. — — A specimen, showing the spirals.

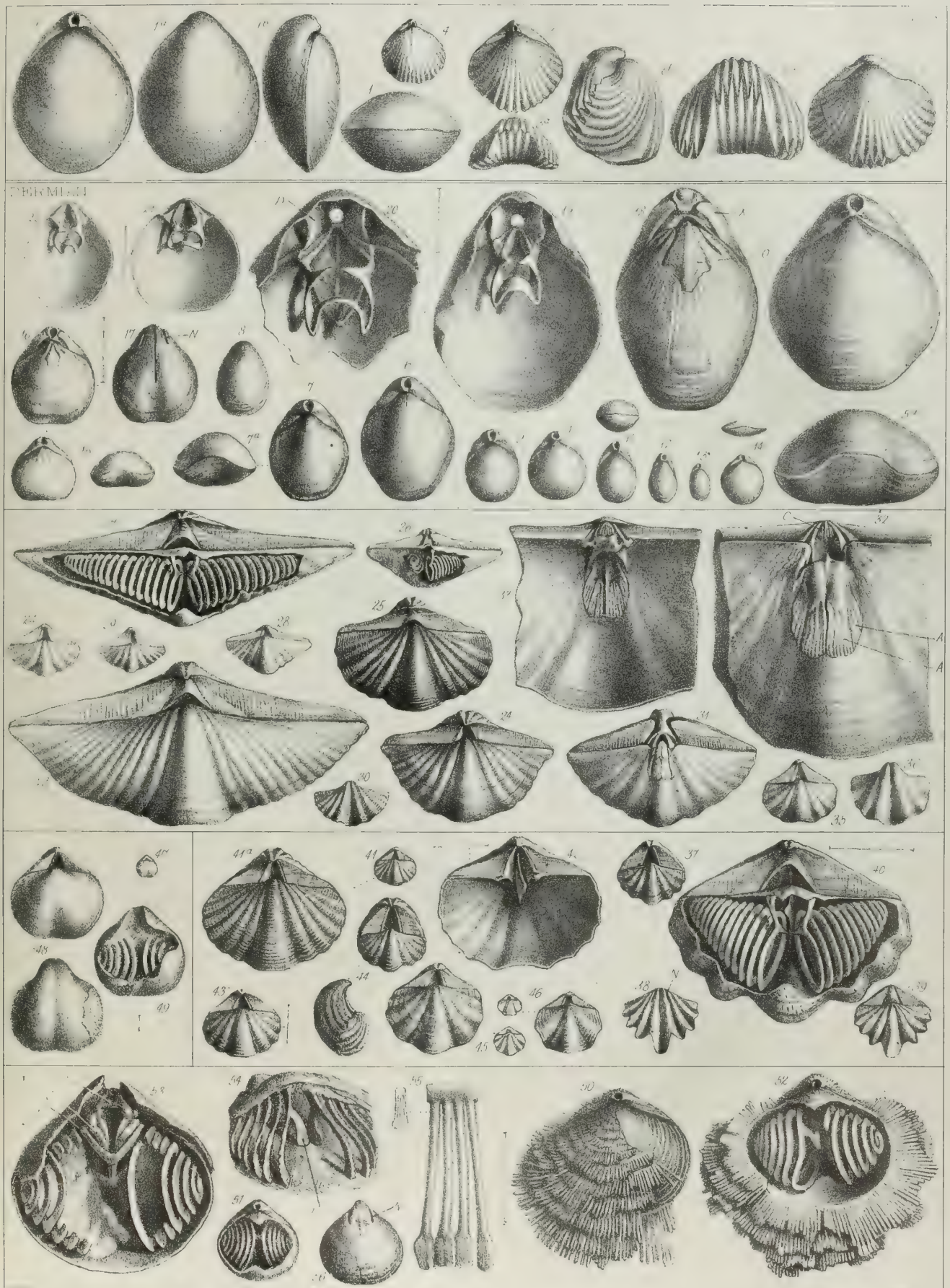
52. — — (Enlarged.) Humbleton hill. Collection of Mr. Kirkby.

53. — — Interior, showing the larger portion of the spirals, but better explained in Plate II, fig. 2. Humbleton. Collection of Mr. Howse.

54. — — From Sowerby's 'Min. Con.,' tab. 616.

55. — — A few of the spinose expansions, enlarged to show how they sometimes expand at their extremities. Humbleton hill. Collection of Mr. Kirkby.

56. — — Internal cast of the ventral valve. The letter N denotes the space left by the dental or rostral plates.



## PLATE II.

(Permian Species.)

Fig.

1. Athyris pectinifera, *J. de C. Sowerby*. Interior. Humbleton.

2. — — This beautiful (magnified) illustration of the interior is entirely drawn from nature, but not from a single specimen. The hinge-plate and its small circular aperture, as well as the dental or rostral plates, have been taken from specimens in the possession of Professor King and Mr. Kirkby. The spirals are from a perfect example discovered by Mr. Howse at Humbleton hill. The spinose expansions are copied from two or three specimens in the cabinet of Mr. Kirkby. This illustration, while correct in its different parts, conveys a clear idea of the complicated internal arrangement.

3. — — The central portion of the spirals, considerably magnified, to show the connecting processes more clearly than in fig. 2.

4. — — A portion of the spiral and connecting process, seen as if the beaks had been removed.

5. — — A fragment of the spiral lamella, showing the spines on its outer edge.

6, 7. Spirifera alata, *Schlotheim*. Internal cast of the ventral valve, to show the adductor (a) and cardinal (r) muscular impressions, as well as the ovarian spaces (*o*), from specimens in the collections of Mr. Howse and Mr. Kirkby.

8. Terebratula elongata, *Schloth.*, var. *sufflata*. Internal cast from a typical example. Humbleton hill.

9. Camarophoria Humbletonensis, *Howse* = *multiplicata*, King. Internal cast, showing portions of the narrow marginal expansions peculiar to this species. Humbleton. Collection of Mr. Howse.

10. — — Front of a very large individual.

11. — — Internal cast, seen from the beaks, in which the impressions referred to the adductor (a) and cardinal muscles (r) ? are exposed. Humbleton hill. Collection of Mr. Howse.

12. — — Internal cast of the ventral valve, showing the cardinal (?) muscular impressions, and the raised band (t) observable in many individuals, but which remains still unexplained. Humbleton. Collection of Mr. Howse.

13, 14. — — Internal casts, from Humbleton, exhibiting the vascular impressions. Collection of Mr. Howse.

15. — — Interior of the dorsal valve, enlarged.

16—18. — Schlotheimi, *V. Buch*. Different ages. Tunstall hill.

19. — — A var. with only two ribs on the mesial fold, and thus hardly distinguishable, except in dimensions, from *C. globulina*. Tunstall.

20. — — A trigonal-shaped specimen, with hardly any indication of ribs, and thus approaching to *T. superstes*, De Verneuil. Tunstall.

21. — — A specimen, showing the large dimensions of the marginal expansions. Tunstall. Collection of Mr. Kirkby.

22. — — Cast of the ventral valve, exhibiting the marginal expansions. Humbleton hill. Collection of Mr. Kirkby.

PLATE II (*continued*).

Fig.

23. CAMAROPHORIA SCHLOTHEIMI, *V. Buch.* Internal cast, seen from the beak, to show the muscular impressions, as in fig. 11. Humbleton hill.

24. — — Interior of the ventral valve, enlarged, minus the marginal expansions. Tunstall hill. Collection of Mr. Howse.

25. — — Fragment, considerably enlarged, to show the hinge and other internal processes, from a very perfect example in the collection of Mr. Howse. Tunstall hill.

26. — — Another fragment, seen more in front.

27. — — Profile section, to show the position of the different parts. Tunstall hill.

28. — GLOBULINA, *Phillips.* Natural size. Tunstall hill. Collection of Mr. Kirkby.

29, 30. — — Two other examples (enlarged), with two and three ribs on the mesial fold. Tunstall hill.

31. — — A fragment of the interior, enlarged, in the collection of Mr. Kirkby. Humbleton hill.

32—36. STREPTORHYNCHUS PELARGONATUS, *Schloth.* Different specimens and variations in shape, from Tunstall and Humbleton hills, in the collections of Messrs. Howse and Kirkby.

37. — — A specimen from Dalton, in the collection of Mr. Howse (enlarged).

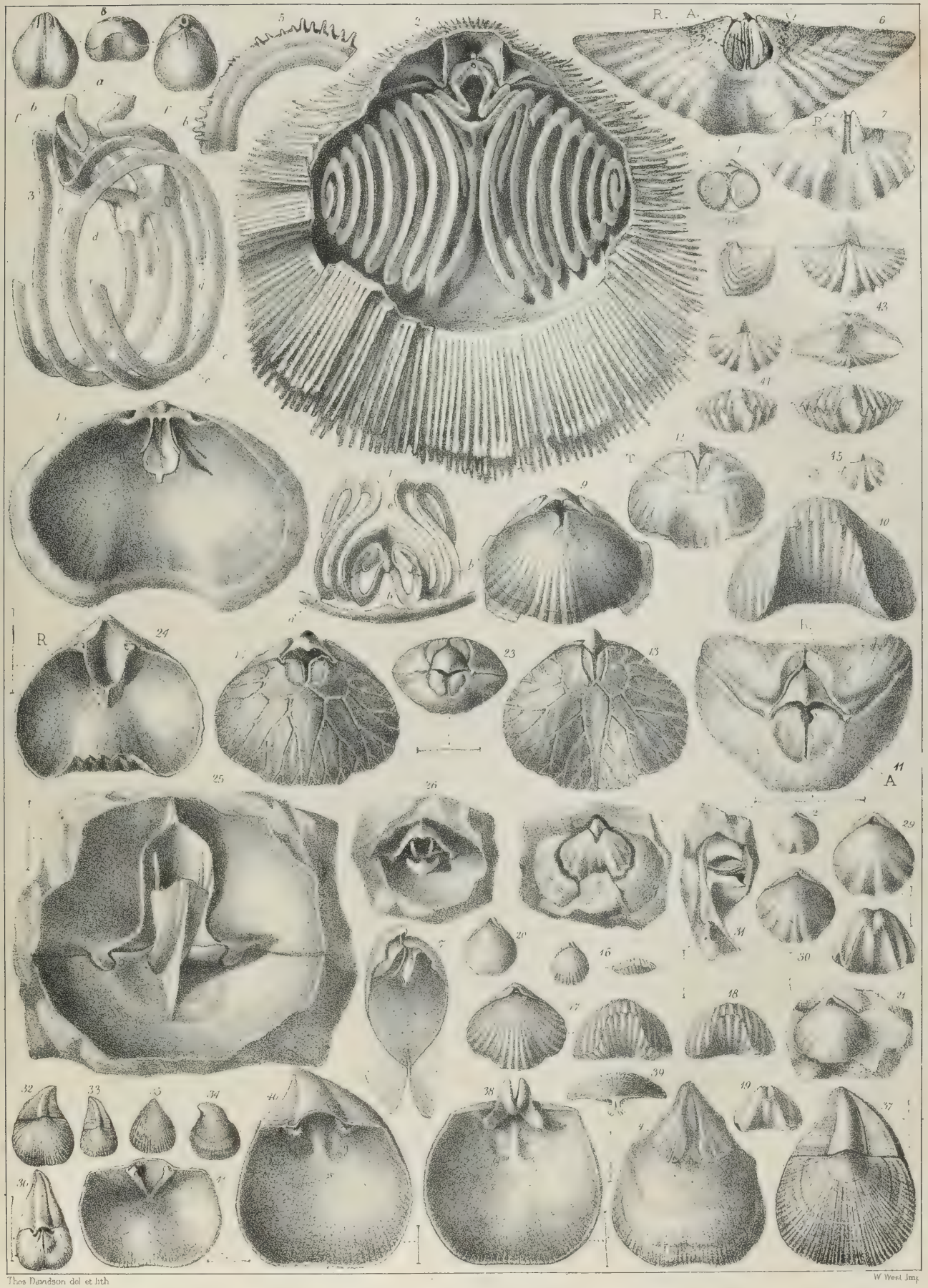
38. — — Interior of the dorsal valve, enlarged. Tunstall hill. Collection of Mr. Howse.

39. — — Dorsal valve, seen from the umbone, to show the bifid cardinal process. Tunstall. Collection of Mr. Kirkby.

40. — — Interior of the ventral valve. Tunstall. Collection of Mr. Howse.

41. — — Interior of the ventral valve, seen under the area, to show the rudimentary dental or rostral plates.

42. — — Internal cast of the ventral valve, showing the position and shape of the muscular scars; from Tunstall hill. Collection of Mr. Kirkby.



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## PLATE III.

(Permian Species.)

Fig.

1—4. Strophalosia Goldfussi, *Münster*. Young shells, from Tunstall hill, in the collection of Mr. Howse.

5, 6. — — Internal casts, from Ryhope-field House.

7. — — Internal cast of the ventral valve, natural size. Humbleton; in the collection of Queen's College, Galway. This specimen exhibits the ordinary condition in which the internal casts are preserved; the adductor impressions are indicated, but no trace of the cardinal muscular ones can be perceived.

8. — — External cast of the dorsal valve, from the same specimen as fig. 7, but enlarged. This specimen was figured by Professor King in his 'Monograph,' pl. xi, fig. 9; but my drawing shows more clearly the manner in which the quadruple impression of the adductor is disposed, and how the reniform impressions divide each pair.

9, 10. — — A remarkable internal cast, from Humbleton, in my collection. Fig. 9 shows the interior of the dorsal valve; fig. 10 that of the ventral one, in which the adductor (A) and cardinal muscular impressions (K) are beautifully defined.

11, 12. — — Internal cast of the dorsal valve. Fig. 12 is a gutta-percha impression, taken from the same, showing the articulation of the valves, &c.

13. — — A very much enlarged representation of the ventral valve, with its long slender spines, a small portion of the shell being removed to show, on the internal cast, the adductor and cardinal muscular impressions; from specimens in the collection of Mr. Kirkby. Humbleton hill.

14, 15. — — Interior of the ventral valve. Humbleton hill. Collection of Mr. Howse.

16, 17. — — A dorsal valve, from Tunstall hill; in the collection of Mr. Kirkby. Fig. 17 shows the remarkable internal margin peculiar to some young individuals.

18. — — *S. parva*, King. From an internal cast, natural size. It adheres to a cast of *Productus horridus*, from Humbleton. In the Museum of Practical Geology; formerly in that of Mr. Howse.

19—22. Strophalosia Goldfussi? var. *Lewisiana*, De Koninck. Slightly enlarged; from Humbleton and Ryhope-field House. Fig. 19 is a cast of the interior of the dorsal valve; 20—22 represent a testiferous specimen, of which the spines are broken.

23. — — var. *Whitleyensis*, King. This is the original specimen from Whitley, now in the collection of Queen's College, Galway, and the one from which Professor King published a gutta-percha impression in pl. xii, fig. 26, of his Monograph.

24—31. Strophalosia lamellosa, *Geinitz*, var. *Morrisiana*, King. From Tunstall hill. Collections of Professor King and Mr. Kirkby.

32—33. — — From Dalton-le-Dale. Collection of Mr. Howse.

## PLATE III (*continued*).

Fig.

34. STROPHALOSIA LAMELLOSA, var. *Humbletonensis*, King. Natural size, from specimens in the collection of Mr. Kirkby. Humbleton hill.

35. — — var. *Humbletonensis*, King. Is an enlarged representation of the dorsal valve and beak of the ventral one, from specimens in the collections of Messrs. Howse and Kirkby. In this specimen the area is visible, but it is sometimes concealed from the incurvation of the beak.

36. — Ventral valve, to show the great length of the adpressed spines. Humbleton. Collection of Mr. Kirkby.

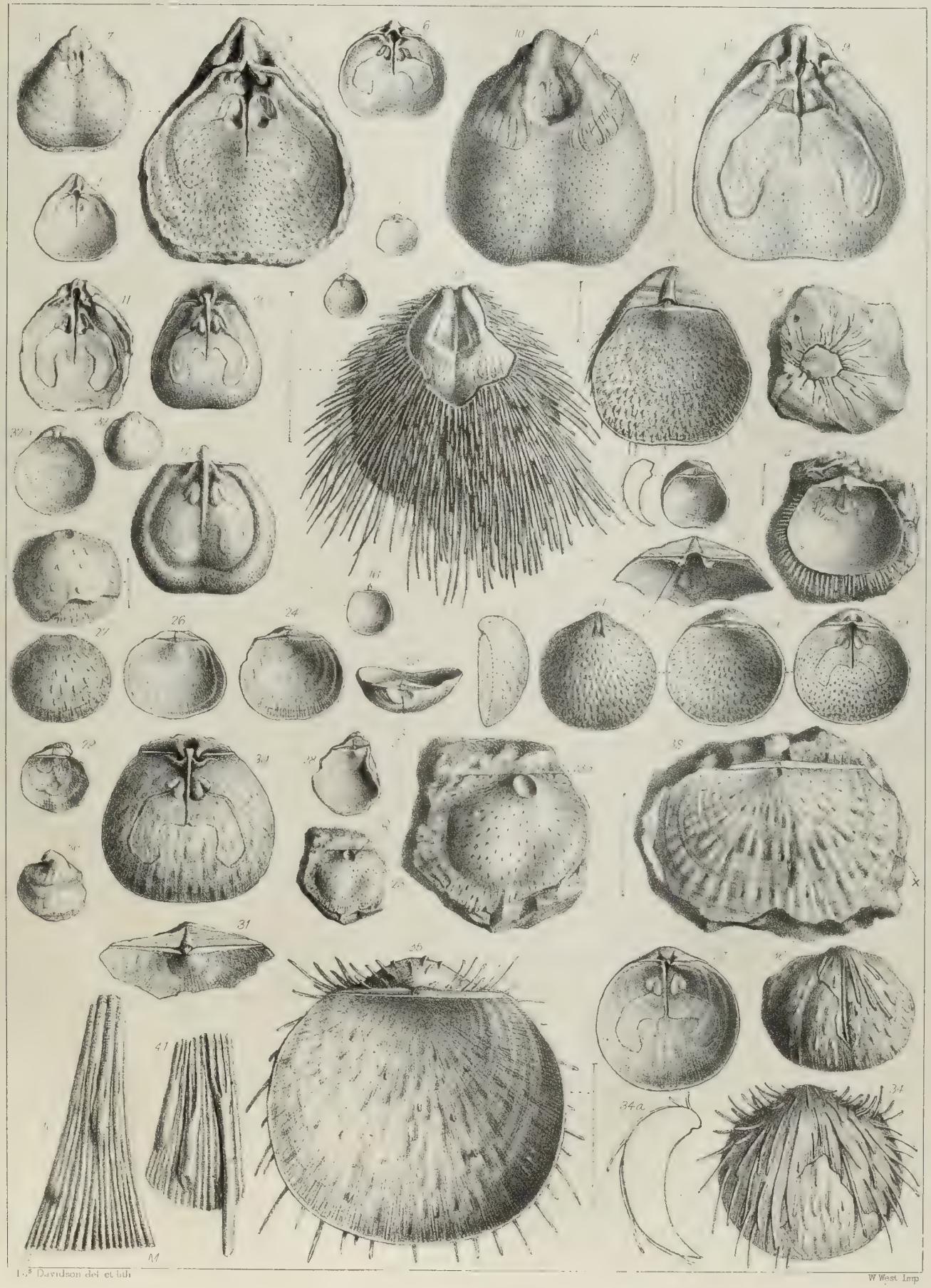
37. — — Internal cast of the interior of the dorsal valve. Humbleton. Collection of Mr. Kirkby.

38. — — Impression of the dorsal valve (enlarged), from Ryhope-field House, proving that, although the valve in question is not spiniferous in the great majority of individuals, they did exist in some few examples. Collection of Mr. Kirkby.

39. — — A gutta-percha impression of the interior of the dorsal valve, to show the articulation of the valves, muscular and reniform impressions, from a specimen in Queen's College, Galway. Humbleton. The internal cast from which the impression here represented was taken is the same figured by Professor King in pl. xii, fig. 30, of his Monograph; but the Professor's illustration was not quite correctly drawn.

40. — — A fragment of the dorsal valve, greatly magnified, to show how the striæ, which cover the surface, augment by intercalation and bifurcation the distance between M and N, representing 2 lines.

41. — — Enlarged portion of the ventral valve, to show how the long adpressed spines sometimes originated from two or three striæ, forming the base of a single spine.



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## PLATE IV.

(Permian Species.)

Fig.

1—4. Productus latirostratus, *Howse* = *umbonillatus*, King. Testiferous examples at different ages, from Tunstall, in the collection of Mr. Kirkby.

5. — — Internal cast of the dorsal valve, natural size, from Dalton. Formerly in the collection of Mr. Howse, now in the Museum of Practical Geology. Fig. 5 *a* is a gutta-percha impression of the same, enlarged to show how the interior of the valve would be in its natural condition.

6. — — Internal cast of the interior of the dorsal valve, a portion of the beak of the ventral one still adhering, in which a narrow open fissure is visible. Collection of Mr. Kirkby.

7. — — Interior of the dorsal valve. Tunstall hill. Collection of Mr. Kirkby.

8—10. — — Different views of the cardinal process (enlarged), from Tunstall hill. Collection of Mr. Kirkby.

11. — — Internal cast of the interior of the dorsal valve (fig. 11), and of the ventral one (fig. 12), showing the position of the adductor (A), and cardinal muscular impressions (R); from Dalton. Collection of Mr. Howse.

12. — — Interior of the ventral valve, from a gutta-percha impression.

13—15. — horridus, *J. de C. Sowerby*. Different ages, from Tunstall and Humbleton hills. Collection of Mr. Kirkby.

16. — — A very perfect example, from Tunstall hill, in the collection of Mr. Howse.

17. — — A portion of one of the tubular spines, enlarged.

18. — — Young shell, from Humbleton hill, collection of Mr. Kirkby, showing the great length of the cardinal spines.

19. — — Internal cast of the dorsal valve, with beak of the ventral one, from Humbleton. Collection of Mr. Howse.

20. — — Internal cast of the dorsal valve, showing the muscular impressions. This specimen is in an admirable state of preservation.

21. — — Interior of the dorsal valve, slightly enlarged, to better display all its characters.

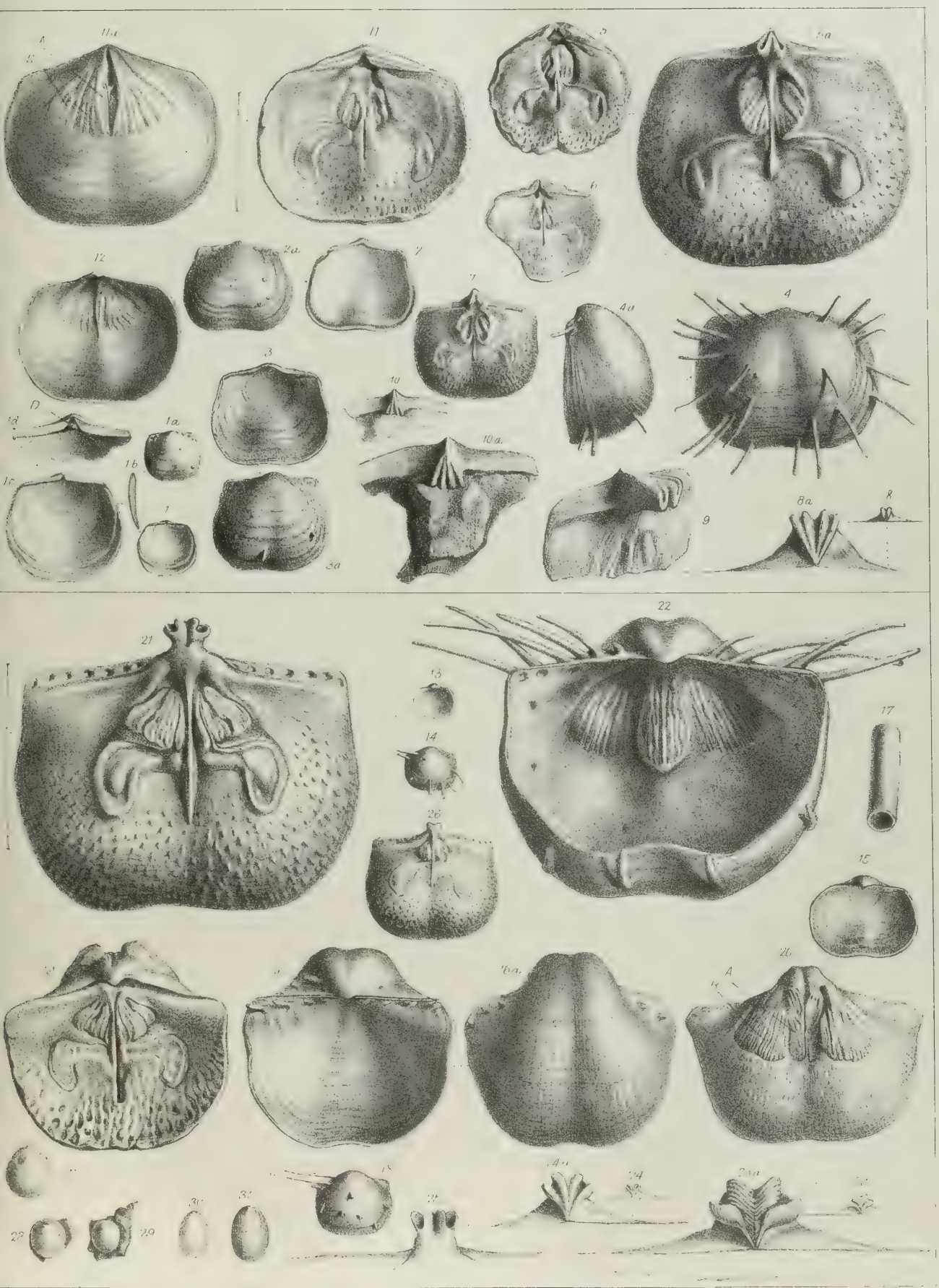
22. — — Interior of the ventral valve; cardinal process considerably enlarged.

23—25. — — Figs. 23 and 24 are seen from the exterior of the ventral valve; fig. 25 from the inside. Collection of Mr. Kirkby.

26. — — Interior of the dorsal valve, from Tunstall hill. Collection of Mr. Kirkby.

27—29. Discina Koninckii, *Geinitz*. Upper valve. From the collection of Mr. Howse and that of the Museum of Practical Geology. Humbleton hill.

30—31. Lingula Credneri, *Geinitz*. Natural size. From Ferry hill. Collection of Mr. Howse.



Tho.s Davidson del et lith

THE

# PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCLVII.

A MONOGRAPH

OF

# BRITISH

# CARBONIFEROUS BRACHIOPODA.

BY

THOMAS DAVIDSON, F.R.S. G.S.,

ETC.

PART V.

LONDON:

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# PRELIMINARY REMARKS.

In the descending order we now arrive at that extensive and important series of rocks to which the term Carboniferous System has been so emphatically applied; a period unequalled for the extraordinary luxuriance of a flora, which in its present fossil condition has proved a source of so much wealth and prosperity to this and other nations: but it is not only the vegetation of its land that has proved so remarkable, the inhabitants of its waters were perhaps almost equally so; and in every respect deserving of the most careful and complete investigation. The system occupies a considerable area in England, Scotland, and Ireland, as may be perceived by a glance at any geological map.[1] It is

[1] We extract the following passage from Mr. Marcou's excellent Memoir on the American Carboniferous Deposits ('Bulletin de la Soc. Geol. de France,' vol. xii, 2d series, p. 844):

"The Carboniferous period is composed of a series of rocks, the importance of which, whether it be considered in the scientific, industrial, or commercial point of view, is neither equalled nor even attained by any of the other sedimentary deposits. In a scientific point of view the Carboniferous group presents the most extended geognostic horizon, of which the characters are constant over all the surface of our terrestrial globe. In Europe, in Asia, in Africa, in the two Americas, as well as in Australia, we meet with the same rocks, and often also with the same fossils; and one is at a loss to know which should be most admired, this consistency in the lithological characters of its strata, or the presence of the same fossils buried in contemporaneous beds, and often situated at the antipodes. From the glacial zone of Spitzberg, the Bear, and Melville Islands, to Australia, Tasmania, and New Zealand, the Carboniferous strata form islands, mountains, table-lands, plains, and even half continents, where the identity and unity of the lithological and palæontological characters exhibit the surest marks of recognition and the most certain horizon that can be found in geological investigations. . . .

"The Carboniferous deposits of America may be divided into an upper and lower deposit:

"*a*. *Upper Carboniferous*, or *Coal measures*, above the mountain limestone, is composed of a series of beds of sandstone and argillaceous schists, containing beds of coal, and which constitutes the Coal formation properly so termed. In America it contains no Brachiopoda.

"*b*. The *Lower Carboniferous*, of which the general character is, so to say, universal; since we observe that it presents well-stratified beds of a hard grayish limestone, replete with numerous marine fossils, similarly found in Europe, America, and Australia. In America it contains *Athyris Roissyi, planosulcata; Sp. striata, lineata;* the *Orthis crenistria, Michelini*; *Prod. semireticulatus, Cora, Flemingii, costatus, scabriculus, pixidiformis, pustulosus*, and others."

made up of a vast accumulation of beds of limestone, shales, indurated clays, grits, coal and sandstone, alternating to a large extent; and which may in different districts or countries be more or less successfully divided into two, three, or even four principal groups, viz.:

1. *The Coal measures* (the uppermost bed of which lies under the *Lower New Red Sandstone* of the Permian series) are composed of a vast accumulation of beds of clay, shale, coal, and sandstone, divided more or less by layers of ironstone and chert. These beds intercalate with each other, and at times also with—
2. *The Millstone grit,* which underlies the Coal measures properly so termed. It is chiefly composed of a coarse-grained, gritty sandstone, not very dissimilar in character from the one found above, but it also alternates with many beds of limestone, shale, and even coal, and presents some of the features of—
3. *The Carboniferous or Mountain Limestone.* These large bands of hard limestone principally prevail in the Yoredale and Scar Limestones of Yorkshire, but they are likewise interstratified with beds of grits, &c.; the series being terminated by lower Carboniferous shales and sandstones, which at times assume a red colour.

But the basement line of the Carboniferous system is still a subject of some divergence in opinion, as certain geologists would comprise within its limits all or portions of the *Old Red Sandstone,* while others consider the strata last named to form part of the Devonian system.[1]

[1] In a most interesting memoir, entitled 'Researches among the Palæozoic Rocks of Ireland,' published in the seventh volume of the 'Journal of the Geol. Soc. of Dublin' (1856), Mr. Kelly is a strong advocate for the admission of what he terms the *Old Red* Sandstone into the *Carboniferous system,* and even seems doubtful as to the propriety of admitting the *Devonian system* in total. It must, however, be here remembered that Mr. Kelly founds his views chiefly on appearances peculiar to Ireland; he also refers to statements made by Dr. M'Culloch (in his 'Treatise on Geology,' 1831), and to the table published by Professor Phillips, at p. 11 of the 'Geology of Yorkshire,' in which the learned Professor divides the Carboniferous system into three principal parts—the *Coal formation,* the *Carboniferous Limestone,* and the *Old Red Sandstone,*—adding at the same time that "the Carboniferous system does undoubtedly permit itself to be considered in three series, characterised by the prevalence of coal, limestone, and red sandstone." Mr. Kelly then states that the Carboniferous formations of Ireland are likewise divisible into a similar triple system, which he seeks to develop in his valuable memoir, to which we must refer the reader for more ample details. It may, however, be observed that bands of red sandstone no doubt occur and form part of the Carboniferous group, but it remains to be a question for further consideration whether the *Old Red Sandstone* of the Devonian period should or not, in part or in total, be considered as a portion of the great Carboniferous system? Sir R. Murchison kindly informs me that there exists in Ireland a series of many thousand feet of shales and grits, &c., above the highest *Upper Silurian,* with all the characteristic fossils, and which represents precisely *in time* the mass of the *Devonian rocks;* and that, from his last year's direct survey of Ireland, his belief is that the Old Red system, Devonian, in Ireland, has undergone a great separation into two parts, which has not occurred in England or Scotland. Professor De Koninck seems also inclined to admit a portion of the

It has been observed by several geologists that "the triple arrangement becomes considerably modified as we proceed towards the north of England and Scotland; for in Derbyshire and Yorkshire the true coal-bearing strata do not cease with the Millstone grit, but are intercalated with it; and in Yorkshire the Limestone (Yoredale rocks) contains several coal seams, flagstones, ironstones, &c.; and still further northwards, in Northumberland and the south of Scotland, the lower Limestone becomes frequently divided by intervening beds of grit, shale, and coal."[1]

To ascertain the true stratigraphical limits of the group is therefore a matter of great importance not only to the geologist but likewise to the palæontologist, because the number of species varies considerably in the different portions of the system; and to offer at present an example, without anticipating the conclusions we may arrive at ourselves after having completed the review of the different species, we will borrow a few lines from p. 244 of the 2d vol. of the 'Geology of Yorkshire,' in order to show what were the numerical proportions arrived at in 1836 by its distinguished author:

| | | |
|---|---|---|
| "Coal formation | . . 3 | species of Brachiopoda. |
| Millstone grit | . . 4 | „ „ |
| Yoredale rocks | . . 29 | „ „ |
| Lower Scar Limestone | . 96 | „ „ |

"It appears to be in the upper part of the *Lower Scar Limestone* that the greatest number of fossils of all kinds occur; they grow continually less and less plentiful as we ascend in the series of the *Yoredale rocks*, *Millstone grit*, and *lower part of the Coal measures*. In the upper part of the Coal series *all* the species vanish."

It was, therefore, during the deposition of the lower divisions of the Carboniferous groups, *i. e.*, of the *Mountain Limestone* and its accompanying shales and sandstones, that the Brachiopoda flourished; while in the upper divisions of the period are entombed the remains of that stupendous vegetation which we all so much admire.

The Brachiopoda of the Carboniferous period are therefore both numerous and widely distributed, and have been partially the subject of several important works published at various intervals both at home and abroad. Still of British fossils they seem to be those perhaps the less generally or completely understood, and especially so if we are to infer from the great extent of misnaming prevalent in almost every public and private collection, not merely in this country but also on the Continent. This unfortunate state of things seems in great measure attributable to the vague and unsatisfactory manner in which certain species have been described and illustrated, as if a few words of description, taken from some obscure fragment at times even imperfectly represented, were sufficient to

*Old Red Sandstone* into the Carboniferous period; but this is not the place for either discussing or enlarging upon such matters, and we must content ourselves by referring the reader for further information to the numerous and excellent geological works and memoirs by Conybeare and Phillips, Buckland, Sir R. Murchison, De la Beche, Prestwich, De Verneuil, De Koninck, and others.

[1] Tennant, 'A Stratigraphical List of British Fossils,' p. 90, 1847.

enable any but the possessor to understand the shape and character of the object thus treated. It, therefore, required a considerable amount of labour and research before I felt myself at all in a competent condition to endeavour to undertake the publication of the *numerous* and *variable* forms which will compose the present monograph.

Having traced on separate sheets the original figures of all those species *said* to have been found in Great Britain, and classed these under their respective genera, according to general affinities and resemblances; my next effort was to procure the loan of the *original specimens* themselves still extant in the United Kingdom, and which were at once communicated in the most kind and liberal manner by their respective possessors. By this means I have been enabled to class, with a greater or less degree of success, the thousands of specimens forwarded from various quarters around the *named* and *original types* of their respective species.

I have stated this in order that the reader may feel assured that, however faulty and imperfect the present work may appear, no effort has been neglected to ensure as far as possible a correct identification of the species by a direct comparison with the original figured types. In a few cases it has not, however, been possible to procure the originals, such as some of those described by Martin, Portlock, and M'Coy—the specimens being no longer to be found; but in those comparatively exceptional cases wherein doubt might prevail, I have invariably reproduced not only the author's descriptions but likewise their figures, as in the instance of *Spirifera transiens*, *Sp. mesogonia*, *Sp. subconica*, &c., but without, however, warranting their specific claims.

After a careful investigation of the various works, I found that considerably more than two hundred species of Carboniferous Brachiopoda were stated to have been found in the United Kingdom, but, as will be hereafter demonstrated, many of these are not British, while others are mere synonyms, or in a great measure attributable to incorrect identifications with Devonian shells, which have been supposed by Professor M'Coy and a few others to be common to both systems. I am very far, however, from wishing to deny that certain forms did continue to live during both the Devonian and Carboniferous periods as well as during the Carboniferous and Permian epochs; but it would be, I believe, a mistaken notion to suppose that they occurred in that numerical abundance which we should be led to believe from the names introduced into Professor M'Coy's otherwise important work on 'Irish Carboniferous Fossils.' Many of these *said* to be Devonian shells were identified from undeterminable or obscure fragments or specimens, at times distorted by pressure and cleavage; and as a large number of them are still extant in Dr. Griffith's collection, Mr. Salter and myself have (through the kindness of their possessor) been enabled to minutely examine and compare a certain number, which invariably turned out to be true *Carboniferous* and not Devonian types. Thus, for instance, M'Coy's so-termed Sp. simplex belonged to *Sp. cuspidata*, Sp. speciosa to *Sp. laminosa*, Athyris concentrica to *A. Roissyi*, &c. These and other incorrect

determinations have tended to add considerable confusion to our notions as to the repartition of species in the two respective systems.[1]

It is well known that the careful stratigraphical and palæontological investigations made in the vast Silurian system by Sir R. Murchison, Mr. Barrande, M. De Verneuil, and others, as well as those conducted throughout the Jurassic, Cretaceous, and Tertiary periods by different competent naturalists, have nowhere exhibited that wholesale mixture or general longevity in time or existence of the numerous species which we should be led to believe did take place in the two above-named epochs.[2] Our researches have hitherto unmistakingly led us to repudiate such an assumption, and to urge us on the contrary to believe that the law which has regulated the vertical distribution of animal forms did not differ in those extended palæozoic systems any further than it did in those of newer or of more ancient date. M. De Koninck states "that he has succeeded in tracing, in the Carboniferous formations of England and Scotland, two great different faunas; the one corresponding to the Carboniferous fauna of Visé and Bleiberg, the other to the fauna of the Tournay coal basin. These two faunas, although contemporaneous, are said to be nowhere found coexistent."[3] But it will be preferable to reserve what we may have to add on this subject until the completion of the descriptions of the species which will compose the present monograph.

So variable do we find the individuals of the same species to be, especially when our examinations are not restricted to a small number of examples (and this more so in certain forms than in others), that we are sadly at a loss in many cases to know how to define and where to confine the limits of variety, and even how to appreciate the value of the characters which are to be brought forward in the discrimination of two different, although closely allied forms. There generally, however, exists a certain *facies* or peculiarity in each combination of individuals that leads the experienced palæontologist to separate, with more or less success, forms which could hardly be identified if unaccom-

[1] These erroneous identifications with Devonian species were published in 1844, and I believe that Professor M'Coy himself repudiates at present the larger number so inscribed; but I have felt myself compelled to draw attention to the point in question, as it is of great importance in our geological and palæontological inductions. The same must be said relative to Mr. Kelly's excellent and most valuable memoir and synoptical table, 'On the Localities of Fossils of the Carboniferous Limestone of Ireland,' published in the 'Journal of the Geological Society of Dublin,' March 14th, 1855, but in which Professor M'Coy's mistaken identifications are reproduced. This most useful work, to which we shall have so often occasion to refer, was published by its author in a great measure to fill up a sad omission in the 'Synopsis,' in which the localities of almost every species had been purposely omitted.

[2] It is true that, in Professor Phillips's work, 'Figures and Descriptions of the Palæozoic Fossils of Cornwall, Devon, and West Somerset,' a very large number of true Carboniferous forms are described as occurring in Devonshire *Devonian strata*, such as at Barton, near Torquay, &c.; but perhaps some of the beds taken as Devonian may be in reality Carboniferous, a point which will require hereafter to be investigated with all possible attention.

[3] 'Proceedings of the Geol. Inst. of Vienna,' 1856; 'Quarterly Journal of the Geol. Soc.,' vol. xiii; and 'Bulletin de l'Académie Royale de Belgique,' vol. xxiii, No. 9.

panied by copious illustrations. The difficulty of discriminating becomes also even more sensible when a genus is largely represented in any single or contiguous group of strata, as are, for example, the *Spirifers* and *Productuses*, which in no other epoch were more varied or half so abundant as in the Carboniferous period; they also here attain their maximum of development both in number of species and proportions, as may be exemplified by the well-known full-grown individuals of *Sp. striata* and *Pr. giganteus*. The comparative length of the hinge line, as well as number of ribs, is so variable, not only according to age but from other natural and extraneous causes, that it becomes at times most perplexing to know where to find words sufficiently precise or explicit, so as to convey a clear idea of those *minute* differences which exist, and which suffice in many cases to warrant the specific or varietal separation of two seemingly allied forms.

It has been my strenuous endeavour, as far as the space at my command would admit, to figure not merely one marked individual, but likewise others less characteristic in their features; that the general observer may feel less embarrassed how to deal with the more numerous intermediate variations in shape, so prevalent among the species of this class of Mollusca.

Among the numerous works and papers which have been consulted during the preparation of the present monograph, I feel bound to call attention to a few British ones in particular, not merely from their importance, but also to satisfy the reader as to the source whence a large portion of our material was derived.

In the valuable 'History of Rutherglen and East Kilbride,'[1] published by David Ure, in 1793, we find some very passable figures of from eleven to twelve species of Carboniferous Brachiopoda, which illustrate in a satisfactory manner a not inconsiderable number of those forms so abundantly distributed in the parishes of Kilbride and Carluke, Scotland; but the author unfortunately does not apply to them any distinctive specific appellations: he classes his specimens into *Anomitæ læves*, *Striatæ*, and *Echinatæ*, the last comprising those species with spines, such as *Productus*. In the 'Mineral Conchology' we find described and illustrated a few more Scottish species, while others are briefly described, but not illustrated, by Dr. Fleming, in his excellent book on 'British Animals,' 1828. In these works, and that of Sowerby, will be found the principal records and illustrations of the Carboniferous Brachiopoda observed in Scotland; but the researches I have undertaken, with the assistance of several kind friends, will enable me to considerably augment the list of the species from that portion of the British Empire, although it has hitherto proved much less prolific than both England and Ireland.

Some years after Ure's publication, W. Martin's work, 'Petrifacta Derbiensia' (1809), appeared, in which about nineteen species of Brachiopoda were described and carefully

[1] It is now a scarce volume, and not generally known, but is well deserving of an honorable mention, being the first work in which Scotch fossils were correctly described and delineated. Specimens identical with and from the localities of David Ure were both lent and presented to me by several Scottish friends, and will be found illustrated in the present work.

illustrated, and of which only two, viz., *Anomites subconica* and *acutus*, have not as yet been properly understood.[1] In the seven volumes of the 'Mineral Conchology,' published at different intervals by James Sowerby and his son, J. de C. Sowerby, will be found good descriptions and illustrations of many excellent species;[2] and in 1836 the second volume of the 'Geology of Yorkshire' was published, in which its distinguished author briefly describes ninety-six forms of Carboniferous Brachiopoda, and of which sixty-three are said to be new, the remaining number being made up from those already described by Martin and Sowerby. All the new species and a few of the old ones are there illustrated, but in general by a single figure only, which was not, however, always sufficient for the clear understanding of the species. Professor Phillips's material was chiefly derived from his own personal exertions, to which was added the Gilbertsonian collection now in the British Museum; and owing to the kind assistance of the author, I have been able to define and completely illustrate certain of his less clearly figured species, such as *Sp. radialis*, *Sp. septosa*, *Sp. humerosa*, &c., which could not have been understood without a personal inspection of the originals, fortunately still extant in the author's cabinet. In 1843 also appeared a 'Report on the Geology of the Coast of Londonderry and part of Tyrone and Fermanagh,' by Colonel Portlock, in which a few new British species were described and illustrated.

While Professor De Koninck was publishing his celebrated work on 'Belgian Carboniferous Fossils,'[3] Professor M'Coy was likewise hard at work on the Irish species,

[1] After the death of Martin a certain number of his original types came into the possession of Sowerby, in whose collection they may be still distinguished.

[2] I beg to refer the reader for information relative to the exact dates of each species published in the 'Mineral Conchology,' to M. E. Renevier's useful list printed in the 'Bulletin de la Société Vaudoise des Sciences Naturelles,' May 2d, 1855. M. Renevier calls attention to the fact that the portion of the work published from June, 1812, to November, 1822, was due to James Sowerby, while the remainder, dating from January, 1823, to January, 1845, is the work of his son, Mr. J. de C. Sowerby, a distinction which should always be attended to.

[3] It is not my present intention to enumerate all the foreign works and papers that have treated directly or indirectly of Carboniferous Brachiopoda, as they will be referred to at their proper places under the respective species; but I cannot pass in silence two most important works published by Professor L. de Koninck, viz., 'Description des Animaux fossiles qui se trouvent dans le Terrain Carbonifère de la Belgique,' 1843, and 'Mongraphie des Genres Productus et Chonetes,' 1847. In these works many British species have been clearly described and illustrated, and, indeed, much more so than in most of our English books. It is true that in certain cases the learned Belgian author did misunderstand a small number of our British types, but when I consider how imperfectly the forms in question were both described and illustrated, without the possibility of a direct reference to the original specimens, I cannot feel surprised that a few mistakes should have occurred, which were unavoidable under the circumstances. Of these some have already been corrected by M. De Koninck himself, in the supplement to his great work, issued in 1851; while a few others will be put right, I trust, in the present monograph.

I may likewise refer the reader to the memoirs of Baron Von Buch; to the 2d vol. of 'The Geology of Russia,' by M. De Verneuil and Count Keyserling, 1845; as well as to the important memoir by Von P. V. Semenow, entitled 'Ueber die Fossilien des Schlesischen Kohlenkalkes,' 1854, &c.

which formed part of Dr. Griffith's valuable collection. His work, 'A Synopsis of the characters of the Carboniferous Limestone Fossils of Ireland,' appeared in 1844, just one year subsequent to the foreign one above referred to. Professor M'Coy describes about two hundred and twenty-eight species of Brachiopoda, stated to belong to the Carboniferous deposits of Ireland! Of these, fifty-eight or fifty-nine are said to be new, and are illustrated in the accompanying plates; but, as already stated, this list has been considerably increased by the unfortunate introduction of a large number of Devonian shells, based upon incorrect identifications. There occurs also many synonyms and other species founded on undeterminable fragments or doubtful malformations, so that when cleared from those intruders the catalogue will be found to be considerably reduced. It is, however, worthy of notice that, although its author has introduced the names of Phillips's, Sowerby's, and some foreign authors' Devonian species, those described and figured by himself are all true Carboniferous specimens, although in several cases not in reality new. The loan of the original examples made use of by Professor M'Coy is a service for which I cannot sufficiently thank their liberal possessor, as it has enabled me to determine a great number of obscure and uncertain forms, which must have continued so had I not possessed the originals to work with. Professor M'Coy has, however, made large amends for the shortcomings of his early book, by the publication of his able and most valuable work, 'On the British Palæozoic Fossils in the Geological Museum of the University of Cambridge.' It contains, among other things, the careful and elaborate description of from ninety-six to ninety-seven species of Brachiopoda of the Carboniferous period, thus adding considerable information to what was already known; but unfortunately, as has been so commonly the case with most authors, he has illustrated but those fifteen which he considered new.

I must now conclude this short notice of the most remarkable British works that have treated of Carboniferous Brachiopoda, by alluding to the valuable 'Catalogue of British Fossils,' prepared with infinite care and patience by Mr. Morris. In his last edition (1854), the author has devoted a certain number of pages to the enumeration and classification of the Carboniferous species into families and genera.

It must, however, have been very generally felt by all who have had occasion to refer to the works above mentioned, how great is the want of correct and more copious illustrations; and it is doubly so in those cases where shells hitherto considered as foreign to the period are introduced for the first time. Under *such* circumstances, a figure is, in my opinion, of *as much importance* as if the shell were actually new, nor can the reader be satisfied as to the correctness of the identification, if he be not provided with some ocular demonstration in the shape of a figure; for it is a well-known fact, that no description, however elaborate in its details, will in natural history compensate for the want of an illustration; or in other words, that with a good figure a short description will often convey to the mind a much clearer idea of the object intended, than the most lengthened one, unprovided with that necessary appendage. I have generally

omitted, among my references, to allude to authors who have furnished simple lists or catalogues of species, because, having no means of ascertaining that these identifications are correct, it would be merely burdening the list of references to no useful purpose.

It now remains for me to express my warmest thanks to those numerous friends who have so zealously assisted me, and who have contributed so largely to the success of the present work by the loan of specimens, and by the advice they have afforded.

To Professor Owen, Mr. Waterhouse, Mr. Woodward, Dr. Gray, and Dr. Baird, for the use of the specimens in the British Museum, wherein so many of Professor Phillips's original figured types are preserved. To Sir R. Murchison and Professor Huxley for the liberal assistance and communication of specimens contained in the Museum of Practical Geology, or Geological Survey; to Mr. Salter and Mr. Baily, of the same institution, for much valued help and useful information. To the Council of the Geological Society, for the kind manner in which they placed the valuable collection of Carboniferous species, forming part of the Society's Museum, at my disposal, for the use of the present work. To Mr. Bowerbank, for all the trouble he has taken relating to this monograph. To Professor Tennant, Mr. Rupert Jones, and Mr. Morris, of London, I am indebted for the loan of many specimens, but in particular to Mr. J. de C. Sowerby, who, in the most liberal manner, gave me the unlimited loan and use of the original specimens described by his father and himself in the 'Mineral Conchology.'

To Professor Sedgwick, for the obliging manner in which he has allowed me free access and use of the specimens in the Cambridge University Museum, and in which are assembled a large proportion of Professor M'Coy's named and original types. Also to Professor M'Coy, Mr. Carter, and L. Barrett, who at various times have kindly assisted in my researches while at Cambridge.

To Professor Phillips, of Oxford, for the loan of his private collection, containing many of the original examples, published in the 'Geology of Yorkshire,' as well as for the kind advice and interest he has taken in the success of the present monograph. To Mr. Etheridge, and the directors of the Bristol Institution Museum for the use of their specimens, as well as to Mr. Charlesworth, and the directors of the York Museum.

To the Earl of Ducie, Dr. Wright, of Cheltenham, Messrs. Walton and Moore, of Bath; Mr. Parker, Mr. Binney, and Mr. Ormerod, of Manchester; Mr. Reed, of York, Mr. Howse, of South Shields, Mr. Tate, of Alnwick, Mr. Muschen, of Birmingham, and the Rev. J. G. Cumming, of Lichfield (formerly of the Isle of Man), for the loan and gift of many specimens, as well as for much valued information connected with the species from their respective districts, or collections. I must, however, here tender my especial and warmest thanks to my valued friend, Mr. Edward Wood, of Richmond (Yorkshire), for the indefatigable and zealous exertions he has displayed in assembling material and information of various kinds; to his kind and liberal assistance this monograph

is much indebted, as he has enabled its author to illustrate and fully describe many important species hitherto involved in much obscurity.

To my Scottish friends and countrymen, it is now my pleasing duty to acknowledge the liberal assistance I have received from them, and among whom I must particularly mention Professor Fleming, who lent all the important Scottish Carboniferous Brachiopoda preserved in his collection, and among which are the originals of those referred to in his work on British animals, as well as several of those figured by Sowerby in the 'Mineral Conchology.' This collection contains the most numerous series of Scottish species I have as yet been able to consult. My thanks are likewise due to the late Hugh Miller, to Professor G. Wilson, Mrs. Rogers, Mr. A. Bryson, and Mr. Rose, of Edinburgh, for the loan and gift of many specimens, as well as for much useful information; to Professor Nicol, of Aberdeen, Mr. Fraser, of Glasgow, Mr. J. Young, and Mr. A. Cowan; and to another friend, who, although unnamed, I feel it a most pleasing duty to express my warmest thanks, for the liberal assistance he has afforded by the loan and gift of specimens derived from Lanarkshire, one of the most important and interesting of our Scottish Carboniferous districts.

To my Irish friends, I am likewise indebted for considerable and most liberal assistance. First, to Dr. Griffith, for the kind manner in which he has lent the Carboniferous Brachiopoda contained in his valuable collection; to Mr. Jukes, for the use of many specimens out of the collection of the Geological Survey of Ireland. To Mr. Carte, for the kind communication of those in the Royal Dublin Museum; to the Rev. Professor Haughton, of Trinity College, Dublin, to Mr. R. Nelson, and to Professor King, of Queen's College, Galway; to Mr. Kelly, of Dublin, I must tender my warmest thanks for his zealous and indefatigable exertions, not only in procuring me a vast number of important specimens, but also for the valuable information he has at all times conveyed on the distribution and localities from which he had himself collected a large number of the types published by Professor M'Coy in the 'Synopsis.'

Among my foreign friends, I might name many who have expressed the most lively interest in the success of the present undertaking, but I must confine myself to those who have communicated specimens and information in connection with Carboniferous species. And among these, it is a most pleasing duty for me to express my grateful thanks to Professor L. de Koninck, of Liege, whose excellent works and extensive knowledge of Carboniferous fossils have proved of so much value in the present investigation. To Count A. V. Keyserling, M. De Verneuil, M. Bouchard, and to all the kind and disinterested friends above named, I again tender my most grateful acknowledgments and thanks.

THOMAS DAVIDSON.

London; June, 1857.

# MONOGRAPH

OF

# BRITISH CARBONIFEROUS BRACHIOPODA.

*Family*—TEREBRATULIDÆ.

*Genus*—TEREBRATULA, *Llhwyd.*

(General Introduction, Vol. I, p. 62; and Part IV, article Terebratula.)

THE species belonging to this genus in the Carboniferous period are but few in number, and, as far as we at present know, are characterised by the short, simple loop peculiar to TEREBRATULA *proper*. The ventral valve, it is true, possesses dental or rostral plates, more developed than in the recent or Jurassic type, but this peculiarity does not appear to constitute a character of sufficient importance for the creation of a separate genus; I must therefore decline adopting the genus *Seminula*, M'Coy, for reasons already assigned.

TEREBRATULA HASTATA, *Sowerby*. Plate I, figs. 1—12.

TEREBRATULA HASTATA, *J. de C. Sowerby*. Min. Con., tab. 446, figs. 1, 2, 3, Jan., 1824.
— — *Fleming*. Brit. Animals, p. 371, 1828.
— — *Phillips*. Geol. of Yorkshire, vol. ii, p. 221, pl. xii, fig. 1, 1836.
— SACCULUS (part), *De Koninck*. Animaux Fossiles de la Belgique, p. 293, pl. xx, figs. 3 $^{a, b}$, 1843.
ATRYPA HASTATA, *M'Coy*. Synopsis of the Carb. Foss. of Ireland, p. 153, 1844.
— VIRGOIDES, *M'Coy*. Ibid., p. 158, pl. xxii, fig. 21.
SEMINULA HASTATA, *M'Coy*. British Palæozoic Fossils, p. 409, 1855.
— VIRGOIDES, *M'Coy*. Ibid., p. 413, Pl. 3 D, fig. 23.

*Spec. Char.* Shell of an elongated, oval, or obscurely pentagonal shape, more or less truncated in front, tapering at the beaks, and widest towards its middle or frontal region; valves almost equally convex, rarely gibbous, with a wide mesial depression or concavity towards the front in the larger number of full grown individuals; beak moderately produced, and but slightly incurved; foramen rather large, oval, and in adult shells approximating the umbone of the smaller valve, so as to conceal much of the deltidium which partly surrounds the aperture; the lateral portions of the beak are somewhat flattened, the ridges being indistinctly defined; the lateral margin of the ventral valve indents the opposite one in the proximity of the beak, and is straight or slightly raised in front; external surface smooth, marked only by a few concentric lines of growth; shell structure minutely perforated. In the interior of the ventral valve there exists two short, diverging, dental or rostral shelly plates, while in the interior of the dorsal one a short, simple loop is observable, occupying about one third or less of the length of the valve. Dimensions variable.

Length 24, width 18½, depth 13 lines.
„ 22½, „ 14, „ 10 lines.

*Obs.* M. De Verneuil and several other authors are of opinion that *T. hastata* should be considered but as a variety of *T. sacculus* of Martin. This view was also advocated, in 1843, by Professor De Koninck, but since abandoned from having observed differences which appeared to him incompatible with the idea that both should be confounded under a single denomination. In his opinion, as well as in that of Professor M'Coy, there exists two adult types, the one being infinitely larger than the other, "which is proved by the thickening of the margin at or under one inch in length (*T. sacculus*), the deeper notch in front, and the mesial sulcus existing at a much smaller distance from the beak than in *T. hastata;* and, above all, the species are distinguished by the great difference of angle at which the valves meet at the margin, the front and lateral margin of *T. hastata* being sharp and wedge-like, but those of *Sp. sacculus* being extremely blunt and obtuse." Such are the characters by which Professor M'Coy distinguishes the two shells; but I confess that at times, and before a large series of both, one feels tempted to look upon these differences as of little value, and to consider the one as a variety of the other. A point worthy of notice is, however, that in no example of the true *T. sacculus* have we observed any trace of those stripes due to colour which are so beautifully preserved in many specimens of Sowerby's shell, such as in those we have illustrated from Derbyshire (figs. 6, 8, 9, 16). It is the opinion of Professor De Koninck and of other authors, that the shell under description may have been intended for "*Anomia attenuata,*" Martin,[1] which was simply characterised by a few vague Latin words; but as

[1] Martin, while alluding to species unfigured in his work, states that "five belong to the Perforati, Fam. *ff*, but only one there is any danger of mistaking for *Sacculus*, it may be distinguished by the following characters: Conch. *Anomites attenuatus.*—C. anomites longitudinaliter ovatus lævis compressus, margine acuto integerrimo."

no one would be able to identify a species from that alone, authors have justly agreed to retain Sowerby's name for the shell under description. *T. virgoides*, M'Coy, does not appear either to Mr. Salter or to myself to present any distinctive characters of sufficient value to warrant its separation from Sowerby's species, as proposed by the Irish author, because it is not uncommon to find that the depression described in *T. hastata* occurs only in one of the valves, while in other cases it is hardly perceptible in either; the front margin is also very variable, being quite straight, and even slightly convex, in some individuals, while in others it presents many degrees of concavity, so much so that some individuals in this respect resemble *T. cornuta*, Sowerby. For similar reasons we are doubtful as to the propriety of admitting *T. ficus*, M'Coy, established from a single shell in the Cambridge Museum; but as we have since been able to examine some other examples, more elongated it is true, but otherwise approaching M'Coy's type, and differing by their extreme convexity and non-indented front from the generality of full-grown examples of *T. hastata*, that it may perhaps appear desirable to provisionally retain for these exceptional forms the varietal denomination of *ficus*, given by Professor M'Coy to his species.

*T. hastata* was ornamented by stripes, in all probability of a red colour, similar to those we find in several recent forms, such as *T. rubella*, *T. pulchella*, &c. They are also very similar to those seen on some specimens of *Terebratula biplicata*, from the Upper Green-sand of Cambridge, as may be perceived by referring to Vol. I, Part II, pl. vi, fig. 6. *T. hastata* has been stated to have been found also in the Permian rocks, but I must confess that I have never observed any specimens that would satisfactorily prove the assertion; nor am I disposed to admit that it and *T. elongata* did belong to the same species, as it has been more than once hinted.

*Loc.* *T. hastata* abounds in many English and Irish localities, but seems to be a much rarer shell in Scotland. I have it from Derbyshire, and in particular from Park Hill, Longnor, and a beautiful series, with their colour-markings, may be seen in the Museum of Practical Geology. It is common at Lowick, Kendal, Settle, Bolland, the Isle of Man, &c. In Ireland it abounds at Millecent, Lisnapaste, Little Ireland, &c. In Scotland at Nellfield, Lanarkshire. It is not a rare fossil on the Continent.

Var. *ficus*, M'Coy. Plate I, figs. 13—16.

SEMINULA FICUS, *M'Coy*. Annals and Mag. of Nat. Hist., vol. x, 2d series; and British Palæozoic Fossils, p. 409, pl. iii D, fig. 22, 1855.

The variety *ficus* is longer than wide, ovate, with convex and gibbous valves, presenting in old individuals a tendency to become obscurely triundate towards the front. The margin in front forms a convex outward curve, which in the ventral valve is likewise slightly raised, and indents to a lesser or greater degree that of the opposite one. The

beak is rather more incurved than in *T. hastata* proper. Dimensions from two examples have produced—

Length $17\frac{1}{2}$, width 15, depth 10 lines (type).
„ $22\frac{1}{2}$, „ 16, „ 12 lines.

*Loc.* Derbyshire, the Isle of Man, &c.

TEREBRATULA SACCULUS, *Martin*, Sp. Plate I, figs. 23, 24, 27, 29, 30.

CONCHYLIOLITHUS ANOMITES (SACCULUS), *Martin*. Petref. Derbesiana, tab. xlvi, figs. 1 and 2, 1809.
TEREBRATULA SACCULUS, *J. de C. Sow.* Min. Con., tab. 446, fig. 1, Jan. 1824.
— — *Fleming*. Brit. Animals, p. 371, 1828.
— — *Phillips*. Geol. York., vol. ii, p. 222; pl. xii, fig. 2, 1836.
— HASTATA (part), *De Koninck*. Animaux Fossiles de la Belgique, p. 294; pl. xx, fig. 3 *c, d, e, f, g, h, l*; not *a, b*, 1843.
— SACCULUS, *M'Coy*. Carb. Foss. of Ireland, p. 156, 1844; and British Palæozoic Fossils, p. 411, 1855.

*Spec. Char.* Obovate, or somewhat obscurely pentagonal, notched and emarginated in front; surface smooth, marked only by a few lines of growth; valves nearly equally deep, and more or less inflated; dorsal valve regularly convex, or with a slight depression near the front. The ventral valve presents a rather deep and concave mesial furrow, commencing at about half the length of the valve, and extending to the front. The margin of the ventral valve is straight in front, or indents by a convex curve the corresponding portion of the opposite one; the beak and foramen are of moderate dimensions, incurved with obscurely marked ridges; shell-structure punctuated. Dimensions variable.

Length 14, width 11, depth 7 lines
„ 8, „ 6, „ 4 lines (Martin's type).

*Obs.* Martin states that "the form of the shell is purse-like, its margin blunt, hollowed out opposite the beak by an obtuse indentation, which is sometimes continued along the back of the beaked valve, in the form of a slight hollow furrow or wave."[1] The last-named character is that which generally distinguishes it best from *T. hastata* and *T. vesicularis;* but, although this peculiar sinus is well and deeply marked in many individuals, it is at times but obscurely so in others, and which occurrence has, no doubt, tempted some authors to unite both Sowerby's and Martin's shell under a single denomi-

[1] In p. 14, of the Systematic Arrangement of the Petrifactions of Martin's species, described in the Petrifacta Derbiensis,' the author again alludes to his *Anomia sacculus* as follows:

*Sacculus.* 24. Conch. Anomites subscrotiformis lævis, margine obtuso: sinu exsculpto. Tab. xlvi, figs. 1, 2.
*a.* v. Sinu à margine ad valvulæ perforatæ dorsum ducto.
*b.* v. Sinu subobsoleto. Tab. xlvi, figs. 1, 2.

nation. The frontal margin of the ventral valve, in the greater number of well-shaped and adult individuals of *T. sacculus*, presents a convex curve, indenting to a lesser or greater degree that of the opposite valve, but without producing in it any sensible mesial elevation. Many examples, wherein the sinus presents a gradual concave curve, bear much resemblance to some young conditions of the Permian *T. elongata* and its var. *sufflata*, so much so that it would be difficult to verbally describe the minute differences which seem to distinguish both species, but which, when full grown, are sufficiently evident.[1] From *T. vesicularis*, De Koninck, *T. sacculus* is very often still more difficultly distinguished; and although both shells are pronounced distinct by Professors De Koninck and M'Coy, I have not been able to arrive at so decided an opinion, for although the frontal wave in most examples of Martin's shell is formed by a single curve, there appears to exist a very gradual passage leading to the triundate wave and frontal plication observable in well-characterised examples of *T. vesicularis*.

As the above-named authors seem to differ with me in this particular, I have provisionally described both under a separate denomination. Some naturalists have proposed to consider *T. pentaedra*, Phillips, and *T. didyma*, of Dalman, as synonyms of Martin's *T. sacculus*, but this mistaken notion has been already objected to by M. De Verneuil, at p. 65 of vol. ii of the 'Geol. of Russia." I am likewise compelled to observe, that M. De Koninck is mistaken while identifying *Anomiæ lævis*, in Ure's 'Hist. of Rutherglen,' p. 313, pl. 16, fig. 9 (1793), with the species under description. It belongs to *Athyris ambigua*, Sowerby, a form that abounds at Lawrieston, as well as in the neighbourhood of Carluke, whence Ure's examples were derived.

*Loc.* *T. sacculus* is common in the mountain limestone. In England it is found at Eyem, Middleton, Moneyash, Cronkstone, Matlock, and other Derbyshire localities; it occurs also at Bolland, Otterburn, Kendal, Malham-moor, &c. In Scotland it is found at Westlothian. Mr. Kelly mentions Ardagh, Millecent, and Little Ireland as Irish localities. M. De Koninck has obtained it at Visé and Chokier in Belgium; but, according to M. De Verneuil and Count Keyserling, it would be rare in Russia, and has hitherto been found but at Cosatchi-datchi, to the east of Miask, in the Oural, and at the mines of Gerichof, Gouvernement of Tomsk, in Siberia.

TEREBRATULA VESICULARIS, *De Koninck*. Plate I, figs. 25, 26, 28, 31, 32; Plate II, figs. 1—8.

TEREBRATULA VESICULARIS, *De Koninck*. Animaux Fossiles de la Belgique (Sup.), p. 666, pl. lvi, fig. 10, 1851.

SEMINULA SEMINULA, *M'Coy* (not of Phillips). British Palæozoic Fossils in the Camb. Mus., p. 412, 1855.

*Spec. Char.* Shell small, ovato-pentagonal, longer than wide, its greatest breadth

[1] Refer to what we have stated on this subject in Part IV, under *T. elongata*.

near the middle. In some adult, and in all young shells, the valves are regularly convex, and moderately inflated, but after a certain age a sinus with two lateral ridges is developed, while a mesial depression, with two lateral ridges and a smaller central elevation or rib, exists in the dorsal one, so that this valve towards the front becomes triundate, forming a W-shaped frontal line, of which the central point is either higher or lower than the lateral ones. The ventral valve is deeper and more inflated than the opposite one, the beak rounded and incurved, ridges obscurely defined; foramen small, oval or circular, and partly surrounded, and separated from the hinge by a small deltidium. Surface smooth, or marked by either few or numerous lines and ridges of growth; shell-structure minutely perforated. In the interior of the ventral valve there exists two moderately developed dental or rostral shelly plates, while in the dorsal one a short, simply attached loop extends to about one third of the length of the valve. Dimensions variable. Three individuals have measured—

Length, 7, width $6\frac{1}{2}$, depth 5 lines.
„ 5, „ 5, „ $3\frac{1}{2}$ lines.
„ $4\frac{1}{2}$ „ 4, „ 3 lines.

*Obs.* This shell is extremely variable, both in shape and character, so much so that, to my eyes, certain examples are undistinguishable from others of Martin's *T. sacculus*, and to which M. De Koninck admits it to be nearly related, but distinguishable in well-grown examples by the triplicated aspect of its smaller valve, as well as by its W-shaped frontal margin. This last appearance is, however, exceedingly variable, for in many specimens the triundate wave is imperceptible, or existing simply in a rudimentary condition. Professor M'Coy seems to have been unfortunate in his researches and appreciations regarding the present form, as appears evident from a glance at p. 412 of the 'British Palæozoic Fossils.' Therein the author refers the shell in question to *Terebratula seminula* of Phillips, which is not only specifically different, but belongs likewise to another genus; for, on the admission of Professor Phillips, as well as in the opinion of Professors De Koninck and Morris, *T. seminula*, Phil., is a true *Rhynchonella*, while the shell so described by Professor M'Coy, in the work above mentioned, is a *Terebratula*. In the 'Synopsis of the Carboniferous Fossils of Ireland,' p. 158, the same author changes Phillips's name *T. seminula* into *Ter. pisum*, but which last is subsequently repudiated in the Cambridge work, the author again returning to that of Phillips. Having, through the kindness of Dr. Griffith, been able to examine the original example upon which the Irish professor had founded his views, it has appeared to me evident that *T. pisum*, M'Coy, is a *Rhynchonella*, which either belongs to Phillips's species, or is closely related to that form, for it is similarly plicated, and does not present the appearance of any example of the shell under description, which Professor M'Coy allows to be the same as *T. vesicularis*, De Koninck, and to which the five specimens in the Cambridge Museum so labelled certainly belong.

*Loc.* In England, it is common in the Craven district, as well as in the Yoredale

rocks of Wensleydale, Yorkshire; at Pilsbury Castle, Longnor, Derbyshire, &c. In Scotland Dr. Fleming has the shell from Westlothian. I am not acquainted with any Irish specimens. In Belgium it is stated by M. De Koninck to occur in the lower Carboniferous limestone of Visé, where it is common.

TEREBRATULA GILLINGENSIS, *Dav.* Plate I, figs. 18—20; Plate II, fig. 1.

*Spec. Char.* Obovate, depressed, smooth, slightly indented in front, widest towards the middle, and frontal region. The dorsal valve is convex at the umbone, but thence to within a short distance of the frontal margin presents a straight or even inward curve. The ventral valve exhibits a flatness in the vicinity of the front, so that this portion of the margin is produced, and forms a convex curve, indenting that of the opposite valve. Beak rounded and incurved, projecting beyond the umbone of the dorsal valve; beak ridges moderately defined; foramen circular, generally approximating the hinge-line, and partially margined by a small deltidium; shell-structure minutely perforated.

Length 9, width $7\frac{1}{2}$, depth 4 lines.

„ 7, „ 6, „ 3 lines.

*Obs.* Numerous examples of this small Terebratula have been collected by Mr. E. Wood, in the Carboniferous beds of Yorkshire. It has been supposed by some palæontologists to be a variety or young state of *Ter. hastata;* while by others it would be referred to the Devonian *Atrypa juvenis* of J. de C. Sowerby. We may also notice that, in the work on the 'Palæozoic Fossils of Devon and West Somerset,' Professor Phillips observes (p. 90), while describing the last-named shell, that, "Mr. Sowerby's figure represents a young specimen; mine is, perhaps, that of a full-grown individual. It is a well-characterised species, though I have specimens supposed to be varieties of *T. hastata,* from the mountain limestone of Yorkshire, whose only distinction is that the widest part of the shell is nearer the front, while in Devonshire forms it is nearer the beaks." Sowerby's figure of *T. juvenis*[1] resembles the young example (Pl. I, fig. 20) of our Carboniferous deposits, but from shells of that age it would not be safe to arrive at a conclusion respecting their specific identity, and especially when we find that there exists so much dissimilarity between the adult condition of *T. juvenis* (as figured by Professor Phillips) and that of our Carboniferous fossil. In the first it is the margin of the dorsal valve that is depressed and convex, while the reverse is the case with the species under description; it exhibits also that dissimilarity in the relative widest part, as was noticed by Professor Phillips. In the work on the 'British

[1] In the 'Trans. of the Geol. Soc.,' 2d series, vol. v, tab. xxxv, Mr. Sowerby describes his *Atrypa juvenis*—"Broad ovate, slightly convex, smooth, curved, longer than wide; front somewhat pointed; valves nearly equal; the lower curved upwards with a minute beak. A small, rather flat species, distinguished by its narrow front, and being curved."

Palæozoic Fossils' (p. 410), Professor M'Coy assimilates both Sowerby's and Phillips's representations of *T. juvenis* with the Carboniferous shell, but I have not been so fortunate as to meet with any agreeing with the adult condition described by Professor Phillips; and the Carboniferous specimens so named in the Cambridge Museum (Plate I, fig. 17) do not certainly represent the Devonian species. This species seems to be easily distinguished from well-authenticated young of *T. hastata* by its more depressed appearance, as well as by the shape and curve of its frontal margin. We have named it after the locality where it abounds, and it will be as well also to notice that all the examples had a reddish tinge, which may perhaps be due to remains of colour.

*Loc.* It abounds at Gilling, in Yorkshire. Dr. Fleming has the species from Westlothian, Scotland (Plate III, fig. 1).

TEREBRATULA (?) SUBTILITA, *J. Hall.* Plate I, figs. 21, 22.

TEREBRATULA SUBTILITA, *J. Hall.* In Howard Stransbury's work, 'Explanation of the Valley of the Great Salt Lake of Utaty,' p. 409, pl. ii, figs. 1 *a*, *b*, and 2 *a*, *b*, *c*, Philadelphia, 1852.

*Spec. Char.* Ovate, longer than wide, and somewhat tapering at the beaks; valves almost equally deep or convex, but most inflated at and about the umbone of the dorsal one; the mesial fold forms a moderately elevated curve, whence the lateral portions of the valves rapidly decline. In the ventral valve, a shallow sinus commences at about half the length of the valve, and extends to the front, which there presents an elevated convex curve, indenting to a lesser or greater degree that of the opposite valve. Beak moderate in dimensions, and but little incurved; the ridges are obscurely defined; foramen circular, and in general contiguous to the umbone of the opposite valve. External surface smooth, marked only by a few lines of growth; interior unknown.

Length 12, width 10, depth 7 lines.
„ 8, „ 7, „ 5 lines.

*Obs.* Of this species I have hitherto been able to examine but two British individuals, obtained by Professor Phillips, in a yellow Carboniferous grit at Mayen Wais, and which appear to be identical with *T. subtilita* of Hall, an opinion first expressed by Professor De Koninck, from the inspection of my figures, before I possessed the means of direct comparison. *T. subtilita* appears to abound in the Carboniferous limestone near the village of Pecos, in the Rocky Mountains of New Mexico, where it is associated with *Prod. semireticulatus* and *Spirifera striata.* It also occurs in the same beds at Sierra Madre and Sierra de Mogoyon, and M. Marcou possesses specimens from the mouth of the Rio San Pedro, in the Rio Gila (Sonora). Professor Hall mentions it from the Missouri.

I am, however, very uncertain whether this shell belongs to the genus *Terebratula,* as

I have not had the opportunity of studying either its interior or intimate shell-structure; this last appearing to be so altered, that I am unable positively to decide whether it was perforated or otherwise. Indeed, some of the American examples in my possession lead me to suppose the structure to be fibrous, and that the species may belong to the genus *Athyris* or *Merista*. It is therefore placed provisionally only into the genus *Terebratula*.

## *Family*—SPIRIFERIDÆ.

### *Genus*—SPIRIFERA, *Sowerby*.

(General Introduction, Vol. I, p. 79.)

SPIRIFERA STRIATA, *Martin*. Plate II, figs. 12—21; Plate III, figs. 2 to 6.

ANOMITES STRIATUS, *Martin*. Pet. Derb., tab. xxiii, 1809.
TEREBRATULA STRIATA, *Sow*. Lin. Trans., xii, part ii, p. 515, pl. xxviii, figs. 1 and 2, 1815.
— SPIRIFERA, *Val.* in *Lamarck*. An. sans Vert., vol. vi, No. 59, 1819; and *Dav.*, Annals and Mag. of Nat. Hist., vol. v, 2d series, p. 449, 1850.
SPIRIFER STRIATUS, *Sow*. Min. Con., tab. 270, May, 1820.
— ATTENUATUS, *J. de C. Sow*. Min. Con., vol. v, p. 151, tab. 493, figs. 3, 4, 5, May, 1825.
— STRIATUS and ATTENUATUS, *Fleming*. Brit. Animals, p. 375, 1828.
— — *Davreux*. Const. Géogn. de la Province de Liege, p. 273, pl. vii, fig. 2, 1831.
— — and ATTENUATA, *Phillips*. Geol. of Yorkshire, vol. ii, pp. 217, 218, pl. ix, fig. 13, 1836.
— — — *Von Buch*. Ueber Delthyris, p. 47, 1837 and 1840.
— — — *De Koninck*. Animaux foss. de la Belgique, p. 256, pl. xv *bis*, fig. 4, 1843.
— STRIATA, *M'Coy*. Synopsis of the Carb. Foss. of Ireland, p. 135, 1844.
— PRINCEPS, *M'Coy*. Ibid., p. 133, pl. xxi, fig. 1.
— ATTENUATA, *M'Coy*. Ibid., p. 129.
— CLATHARATA, *M'Coy*. Ibid., p. 130, pl. xix, fig. 9.
— STRIATA, *De Vern*. Russia and Oural, vol. ii, p. 167, pl. vi, fig. 4, 1845.
— — *M'Coy*. British Palæozoic Fossils, p. 222, 1855.

*Spec. Char.* A very large and variably shaped shell, transversely semicircular, or sub-rhomboidal; valves almost equally convex. In the dorsal valve the mesial fold is of moderate elevation, while the sinus in the opposite one is both variable in its width

and depth. The hinge-line is either a little shorter, or as long as the greatest width of the shell, the cardinal angles being more or less rounded in adult individuals. The area is of moderate width, with sub-parallel sides; fissure triangular, and partially covered by a pseudo-deltidium. The external surface of the shell is ornamented by a variable number of radiating ribs, which augment in number, to a greater or lesser extent, from intercalations at unequal distances from the beaks; so that from seventy to ninety may be counted round the margin of each valve in adult individuals. The ribs on the fold and sinus are likewise more flattened than on the lateral portions of the shell. The surface is closely and finely reticulated. In the interior of the dorsal valve, under the extremity of the incurved umbonal beak, there exists a small cardinal process or muscular fulcrum, and on either side are situated the dental sockets. The spiral cones which fill the larger portion of the shell are attached to the extremities of the inner socket-walls. The lamellæ, after having converged and given birth to the crural processes, diverge, and form the first of the twenty or twenty-two convolutions of which each spiral is composed. Four impressions left by the adductor muscle are visible in this valve. In the interior of the ventral valve a strong hinge-tooth is situated on either side at the base of the fissure, and is supported by a vertical shelly plate of much strength, but not advancing to any great length into the interior of the valve. Between these a large portion of the free space at the bottom of the shell is occupied by the adductor and cardinal muscular impressions, which are divided by a blunt, central, longitudinal ridge. The dimensions of one of the largest examples are—

Length $4\frac{1}{2}$ inches, width 6 inches 1 line, depth 3 inches 1 line.

*Obs.* In the opinion of M. De Koninck, De Verneuil, M'Coy (1855), as well as of other authors, *Sp. attenuata*, Sow., must be considered as a synonym of *Sp. striata* of Martin; and in this view I am the more disposed to concur, from having been able to assemble and study upwards of four hundred individuals of this shell, from the dimensions of a few lines to those of the largest example above recorded. With so numerous a series before me, all minor differences, so remarkable when particular or exceptional forms are placed in comparison, soon vanished, and I can see in them nothing further than those dissimilarities so common to individuals of every species composing the animal kingdom; for it is a well-known fact that no two examples are ever found to be so exactly similar as to induce one to suppose that they were cast in the same mould, and it has also been well ascertained that under certain conditions individuals of most species may become adult with much smaller dimensions in one locality than in another. The number of ribs or external sculpture varies also to a considerable extent in different specimens. This is no doubt the reason why at Millecent (Kildare) we may meet with upwards of a thousand middle-sized specimens for one large individual, while in other localities the proportions are on an average much larger. The name *Sp. princeps* was given by Professor M'Coy to a full-grown example of Martin's *striata*, and must therefore be added to the synonyms of that form. M. De Verneuil is also of opinion

that *Sp. condor* (D'Orb),[1] represents an individual of *Sp. attenuata;* and I possess specimens from the same locality as those described by the French author, which entirely agree with the species under description. Professor M'Coy is also of opinion that what he described in 1844 as *Sp. clatharata*, must be added to the list of synonyms.

The long hinge-line of *Sp. striata* distinguishes it from *Sp. duplicicostata* of Phillips, but to which it is, however, very closely related by several peculiarities, for many examples of *Sp. striata* present not only similarly bifurcated and intercalated ribs, but these are also at times arranged in clusters, as is generally the case in Phillips's species. The elevation and proportions of the mesial fold varies also considerably, and in some young and middle-aged shells from Millicent it is badly defined; these last being also much more elongated and spindle-shaped than is commonly the case; while others are rhomboidal, with or without prolonged cardinal angles. The ribs on the mesial fold present at times (although much more rarely than in *Sp. bisulcata*) a tendency to divide into three groups separated by deeper sulci; but, as above observed, all these minor differences so remarkable, in single individuals, are, specifically, of little importance.

*Sp. striata* is the largest Spirifer known, and must always be considered as the type of the genus. There are many varieties, but I shall simply allude to the one found at Dovedale, Derbyshire (Plate II, figs. 15, 16), in which the ribs become so narrow and numerous, that one hundred may be counted round the margin of each valve in certain individuals, giving the shell much the appearance of the Silurian *Sp. cyrtæna.*

*Loc.* This species is found at Castleton, Dovedale, and other Derbyshire localities; at Bolland, and different parts of Yorkshire. In Ireland Mr. Kelly mentions Ratheline, Millecent, Little Ireland, Lisnapaste, Cornacarrow, Ardclogh, &c. In Scotland it appears extremely rare, for I have not been able to find any well-authenticated example in the different collections I have been able to examine. It seems to be a rare fossil at Visé, in Belgium, but more common at Ratingen. M. De Verneuil found it at Cosatchi-datchi (east of Miask), on the other side of the Oural Mountains; also at Pos-en-Cavales (Spain). It is one of the most characteristic fossils of the lower Carboniferous limestone, being found in various American localities, such as Yarbichambi, at 4000 métres of elevation, north of La Paz (Bolivia), as well as in the Quebaya Island, in the Sea of Titicaca. M. Marcou obtained it abundantly in the Rocky Mountains, as well as from New Scotland to Vancouver's Island.

[1] 'Voyage dans l'Amérique Méridionale,' vol. iv, pl. xlvi, figs. 11—15.

SPIRIFERA MOSQUENSIS, *Fischer de Waldheim.* Plate IV, figs. 13, 14.

CHORISTITES MOSQUENSIS, *Fischer.* Programme sur les Choristite, p. 8, No. 1, 1837; and Oryctogr. du Gouv. de Moscow, p. 140, pl. xxii, fig. 3; pl. xxiv, figs. 1—4, 1837.

— SOWERBYI, *Fischer.* Ibid., pl. xxiv, figs. 5, 6, 7, pl. xxv, fig. 6. (Not Spirif. id. *Defrance.*)

— KLEINII, *Fischer.* Ibid., pl. xxiv, figs. 8, 9.

DELTHYRIS INCISA, *Goldf.* German Translation of the Manual of De la Beche, p. 526, 1832.

SPIRIFER CHORISTITES, *Von Buch.* Ueber Delthyris, p. 45, 1837; and Mém. de la Soc. Géol. de France, vol. iv, p. 191, pl. ix, fig. 16.

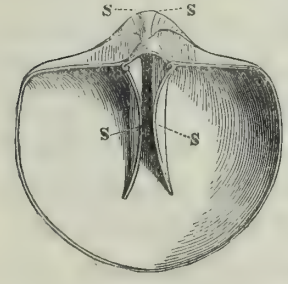
— PRISCUS, *Eichwald.* Urwelt Russl., Heft i, p. 97, pl. iv, fig. 12, 1840.

— CHORISTITES, *M'Coy.* Synopsis, p. 130, 1844.

— SOWERBYI, *De Koninck.* Desc. des Animaux fossiles de la Belgique, p. 252, pl. xvi, fig. 1, 1843.

— MOSQUENSIS, *De Verneuil* and *Keyserling.* Russia and Oural, vol. ii, p. 161, pl. v, fig. 2.

*Spec. Char.* Semi-oval, or of a lengthened semicircular shape, transverse when young, more or less elongated in the adult condition; valves convex, and somewhat inflated with a rather wide but not greatly elevated fold in the dorsal, and shallow sinus in the ventral valve. The hinge-line is generally as long as the greatest width of the shell; the area has sub-parallel sides, with a triangular fissure partially covered by a pseudo-deltidium. The beaks are incurved and approximate. Externally each valve is ornamented by from fifty-five to sixty-five narrow, simple, or intercalated radiating ribs, of which from twelve to sixteen occupy the sinus and mesial fold. The ribs in both valves are likewise intersected by numerous concentric lines or ridges of growth, which become the more approximate as they approach the margin. In the interior of the ventral valve a strong tooth is situated on eitherside at the base of the fissure, supported by two large, vertical, shelly plates, which extend from the extremity of the beak to the bottom of the valve, first forming the fissure walls, then converging to diverge again, and extending to a distance of two thirds of the length of the valve. Dimensions variable.




*Spirifera mosquensis.* Interior of the ventral valve. S, septa.

Length $22\frac{1}{2}$, width 23, depth $14\frac{1}{2}$ lines.

*Obs.* This species has been described to considerable length by both MM. De Koninck and De Verneuil, the last-named author having drawn particular attention to those large dental or rostral plates observable in the ventral valve, which distinguish it from *Sp. striata* of Martin. These shelly plates or septa have been illustrated in Pl. VI of our General Introduction, as well as in pl. v, fig. $2^b$, of the 'Geology of Russia.'

The very few British examples of this species which I have been able to examine

did not present any interior, but the external characters are so exactly similar to some Russian examples from the Donetz at Moscow and Viterga, that I have felt no doubt as to their identity. *Sp. mosquensis* is also very variable in its proportions, and (as observed by one of the above-named authors) shows a marked tendency to elongation, especially in the adult condition. Thus, some Russian specimens measured 27 lines in length by 22 in breadth; and a Belgian example, figured by M. De Koninck, attained still larger dimensions (38 lines in length by 39 in breadth).

*Sp. mosquensis* is distinguished from *Sp. striata* by its much more elongated appearance; from *Sp. bisulcata* it is separable by its more numerous and smaller ribs, and approaches most to *Sp. humerosa* of Phillips, but from which it is likewise distinguished by a smaller and less inflated beak than that peculiar to Phillips's species.

Both MM. De Koninck and De Verneuil have remarked that the shell under description must not be confounded with that named *Sp. Sowerbyi* by Defrance, in the 'Dictionnaire des Sciences Naturelles,' vol. 50, p. 295, pl. lxxvi, fig. 2, which belongs to a specimen of *A. reticulata* of Linnæus.

*Loc.* In England it is found near Bristol. A specimen is also labelled Derbyshire in the Cambridge Museum. In Ireland it has been collected from Little Ireland; but I have not hitherto observed any example from Scotland. In Belgium it is stated by M. De Koninck to occur abundantly near Tournay, d'Ath, de Soignies, de Felay, &c. Fischer de Waldheim obtained it from a white Carboniferous limestone at Grigorievo, Podolsk, Miatchkovo, and other localities in the neighbourhood of Moscow. M. De Verneuil found it to be one of the most characteristic shells of the middle beds of the Carboniferous system throughout Russia and Oural, being there associated with *Productus gigas* and other shells.

SPIRIFERA HUMEROSA, *Phillips*. Plate IV, figs. 15, 16.

SPIRIFERA HUMEROSA, *Phillips*. Geol. of Yorkshire, vol. ii, p. 218, pl. xi, fig. 8.

*Spec. Char.* A ponderous shell, variable in shape, sometimes transverse, but more often elongated; valves convex; beak large and considerably inflated, much incurved, with a wide, shallow sinus, extending from the extremity of the beak to the front. Hinge-line shorter than the greatest width of the shell. Area narrow. Dorsal valve convex, with a produced, rather angular mesial fold; frontal wave strongly marked, the margin of the sinus indenting to a considerable extent the corresponding portion of the dorsal valve. Surface ornamented by numerous small ribs, which augment rapidly from numerous intercalations; the ribs are more or less flattened, especially on the mesial fold, and are at the same time intersected by numerous concentric lines or ridges of growth. Dimensions very variable.

Length 2 inches 7 lines, width 2 inches 2½ lines, depth 1 inch 6½ lines.
„ 2 inches, „ 2 inches 6 lines, „ 1 inch 6 lines.

*Obs.* Professor Phillips describes this species with "a lower (ventral) valve swollen near the beaks, and *produced* in a mesial furrow receiving the angular ridge of the upper valve; radiating ribs small, duplicate. *Loc.* Greenhow Hill." The figure published in the 'Geology of Yorkshire' is very unsatisfactory; but, having received the loan of the original specimen, I have drawn it correctly in Pl. IV, fig. 15, so that no doubt may exist regarding its identification with the perfect example, fig. 16, in the possession of Mr. Wood, of Richmond. Professor Phillips's specimen is very incomplete and fragmentary, but still exhibits the characters of the species; and what gives his figure such an extraordinary beak is, that the valves were widely separated while the shell was filling with matrix, so that, in addition to the real beak, a larger portion of the ventral valve is seen than would have been the case had the valves been closed. In fig. 15$^a$ I have given a profile view of the specimen, to satisfy the reader of the correctness of this assertion.

I have been able to examine six individuals of this remarkable shell, but they did not all possess the elongated shape figured in our plate. Some were much shorter and transverse, as will be seen from the measurements already given, and selected from two extreme examples. Its ponderous shape, shorter hinge-line, and smaller ribs distinguish it from Martin's *Sp. striata.*

*Loc.* Greenhow Hill, and Wensleydale, Yorkshire.

SPIRIFERA DUPLICICOSTA, *Phillips.* Plate III, figs. 7—10; Plate IV, figs. 3, 5—11.

SPIRIFERA DUPLICICOSTA, *Phillips.* Geol. of Yorkshire, vol. ii, p. 218, pl. x, fig. 1, 1836.
— FASCIGER, *Keyserling.* Wissenschaft Beobach. Petchora Land., tab. viii, fig. 3.
— FASCICULATA, *M'Coy.* British Palæozoic Fossils, tab. iii D, fig. 25, 1855.

*Spec. Char.* Transversely sub-rhomboidal when adult, longer than wide, or almost circular when quite young; valves moderately convex, with a more or less produced mesial fold in the dorsal, and a corresponding sinus in the ventral one. The hinge-line is shorter than the width of the shell, the area of moderate breadth, beak incurved. Valves ornamented by numerous radiating ribs, which rapidly augment at various distances from the beaks by intercalation as well as bifurcation. Two examples have afforded the following measurements:

Length 16, width 20, depth 11 lines.
„ $16\frac{1}{2}$, „ $17\frac{1}{2}$, „ $10\frac{1}{2}$ lines.

*Obs.* Professor Phillips describes his species with "mesial fold angular; radiating ribs numerous, duplicate towards the margin." No form is, however, more variable than the one under description, both as to shape, dimensions, and character of plication; and

although almost circular when young (Pl. IV, figs. 7, 9, 10, 11), it is in general more or less transversely oval, or sub-rhomboidal, in the adult condition (Pl. III, figs. 9—11; Pl. IV, fig. 6), the last having been considered by Professor Phillips to represent the typical form of his species. The ribs differ also much, being either only here and there duplicose, or, as is the case with many examples, having three or four ribs clustered together, and thus producing a very remarkable appearance (Pl. IV, fig. 6). The term *duplicicosta* is not, however, very appropriate, since many species of *Spirifera* present that peculiarity, which is also observable to a lesser degree in *Sp. striata*, to which Phillips's form is very closely related. Professor M'Coy has likewise proposed to unite to the present species the one named *Sp. crassa* by M. De Koninck = *planicosta*, M'Coy; and although the learned Irish author may perhaps be correct in his identification, I do not as yet feel myself prepared to admit the point as an established fact. *Sp. crassa* seems to constitute a form intermediate in character between *Sp. duplicicosta* and *Sp. bisulcata* of Sowerby, but I have not been able to examine a sufficient number of species to decide the point to my own satisfaction. Professor M'Coy's illustrations of *Sp. faciculata* (Pl. IV, fig. 11) so closely resemble many well-authenticated examples of the shell under description, that I have, with the sanction of both Professors Phillips and De Koninck, added it to the synonyms of *Sp. duplicicosta*. *Sp. fasciger*, Keyserling, evidently belongs to the same species, and has been so admitted by Professor M'Coy.

*Loc.* Common in many Carboniferous localities, such as in the Great Scar Limestone of Park Hill, Longnor, Derbyshire; at Bolland and the Craven district; at Lowick, in Northumberland; at Kendal; and Poolvash, Isle of Man. In Scotland, Mr. J. Young and Dr. Fleming possess it from Corieburn (Campsie), in Lanarkshire, as well as from Westlothian. In Ireland, it is mentioned by Mr. Kelly as occurring at Lisnapaste, Malahide, and Mullaghfin.

SPIRIFERA CRASSA, *De Koninck*. Plate VI, figs. 20—22; Pl. VII, figs. 1, 2, 3.

SPIRIFER CRASSUS, *De Koninck*. Animaux fossiles de la Belgique, p. 262, pl. xv *bis*, fig. 5, 1843.
BRACHYTHYRIS PLANICOSTA, *M'Coy*. Synopsis of the Carb. Foss. of Ireland, p. 146, pl. xxi, fig. 5, 1844.
SPIRIFERA CRASSA, *D'Orbigny*. Prodrome, vol. i, p. 149.
— DUPLICICOSTA, *M'Coy*. British Palæozoic Fossils, p. 415, 1855.

*Spec. Char.* Transversely oval; valves almost equally convex, and somewhat inflated; hinge-line shorter than the greatest width of the shell; area triangular, of moderate width, with cardinal angles rounded off. Beak small, incurved, not much produced. The mesial fold is but slightly raised above the level of the lateral portions of the valve; sinus wide, not very deep. The valves are ornamented with from forty-five to seventy narrow, rounded,

unequal, bifurcated, or intercalated ribs, of which from ten to twelve occupy the surface of the mesial fold and sinus. The following are the measurements from two examples:

Length 28, width 36, depth 23 lines.

„ 22, „ 30, „ 13 lines.

*Obs.* I have been able to examine very few examples of the present form, but these varied considerably both in degree of convexity as well as depth. The mesial fold is never much elevated, and is at times scarcely defined, as in Pl. VII, figs. 1 and 3; so that some examples show hardly any frontal wave. The ribs also vary much in their respective widths, even on the same individual, so much so that some specimens seem hardly distinguishable from *Sp. bisulcata*, while others approach most to *Sp. duplicicosta;* it seems however, to be much more regularly oval than is commonly the case with Phillips's species, in which the mesial fold is also generally more elevated, giving to the shell a different aspect. From *Sp. bisulcata* it seems distinguished by the shortness of its hinge-line.

*Loc.* Dr. Griffith's examples are from the lower limestone of Mullaghfin and Milverton, in Ireland. A fine specimen in the Cambridge Museum is labelled Derbyshire. It is not very rare at Visé, in Belgium, whence Professor De Koninck's types were derived.

### Spirifera planata, *Phillips*. Plate VII, figs. 25—36.

Spirifera planata, *Phillips*, Geol. of Yorkshire, vol. ii, p. 219, pl. x, fig. 3, 1836.
Brachythyris planata, *M'Coy*. Synopsis of Carb. Foss. of Ireland, p. 146, 1844.
Spirifer rotundatus? *Semenow* (non *Martin*). Ueber die Fossilien des Schlesischen Kohlenkalkes, 1854.
— recurvatus, *M'Coy* (non *De Koninck*). British Palæozoic Fossils, p. 421, 1855.

*Spec. Char.* Almost circular or ovato-subtrigonal, often as wide as long; hinge-line shorter than the width of the shell; area triangular, of rather small dimensions. Dorsal valve moderately convex, uniformly so in young and even aged individuals, so that there hardly ever exists a regularly defined mesial fold, its position being in general indicated by two deeper sulci. The ventral valve is much deeper and more convex, with a narrow longitudinal sinus, producing but a slight frontal wave; beak prominent and incurved. The surface of the valves are ornamented by numerous delicate radiating ribs, four or five occupying the place of the fold, while from thirteen to fifteen exist on either side, several of which being due to intercalation at various distances from the beaks.

Length and width rarely exceeding 9 or 10 lines, depth from 5 to 6 lines.

*Obs.* This pretty little shell is a well-characterised and readily recognisable species, but from not having been sufficiently described in the 'Geology of Yorkshire,' has given rise to some false identifications, not only abroad but likewise at home; for in the

Cambridge Museum we find the species, both labelled and described by Professor M'Coy as *Sp. recurvatus* of Professor De Koninck. For a long time I considered the Belgian form last named to be synonymous with the British species, but am positively assured by Professor De Koninck that they are distinct; and that, although both are found in Belgium, they do not occur in the same beds. The characteristic shape of the adult shell is represented by figs. 26, 27, 31, and 35; fig. 26 being drawn from one of Professor Phillips's typical examples in the British Museum; fig. 31 is from another in his own collection. The specimens selected for illustration exhibit the different aspects and character of striation presented by this species, and it will be observed that in the young state (fig. 36), and often even up to an advanced age (fig. 33), the regular convexity of the valves is undisturbed by either sinus or fold, both valves being covered by numerous slightly produced striæ. In other examples (figs. 26 and 35) a distinct, narrow, and obscurely defined flattened fold is visible; a sinus in the opposite valve being also perceptible, which is, however, deeper in some exceptional examples (fig. 28). These variations have their influence on the frontal wave, which is at times hardly perceptible; while at others, as in figs. 31 and 38, it is clearly defined. The number of ribs is also very variable, being smaller or larger according to individuals, and increased by intercalation. I have counted from thirty to thirty-eight round the margin of the smaller valve, four or five occupying the place of the fold where such is regularly defined.

In the 'Synopsis of Carb. Fossils of Ireland,' Professor M'Coy states—"It appears to me that this species (*Brachythyris planata*) is the shell intended by Martin as his *Anomites rotundatus*, and not *Spirifer rotundatus* of Sow." This is, however, a mistake, as the young of *rotundatus* is certainly that of the species of which Sowerby published the adult at a later period, and does not possess the character of *planata* of Phillips. Professor M'Coy gives to his Irish specimens the dimensions of 1 inch in length and width, which surpasses that of any of the numerous English examples I have been able to examine. M. Semenow has also fallen into the same mistake.

*Loc.* Common at Bolland, whence Professor Phillips obtained his types. Those in the Cambridge Museum are labelled Derbyshire. It occurs also at Settle, in Yorkshire, as well as in the Isle of Man (Dr. Cumming). Mr. Kelly quotes Bundoran, Ardclogh, and Little Ireland, as the Irish localities. I am not acquainted with any Scotch example. M. De Koninck has it from Vaulsort, near Dinant, in Belgium.

SPIRIFERA TRIANGULARIS, *Martin*, sp. Plate V, figs. 16—24.

CONCHYLIOLITHUS ANOMITES TRIANGULARIS, *Martin*. Pet. Derb., pl. xxxvi, fig. 2, 1809.

SPIRIFER TRIANGULARIS, *Sowerby*. Min. Con., tab. 562, figs. 5, 6, May, 1827.

— — *Von Buch*. Mém. Soc. Géol. de France, vol. iv, p. 182, pl. viii, fig. 5, 1840.

SPIRIFER TRIANGULARIS, *De Koninck*. Animaux fossiles de la Belgique, p. 234, 1843.

— ORNITHORHYNCHA, *M'Coy*. Synopsis of the Carb. Foss. of Ireland, p. 133, pl. xxi, fig. 2, 1844; and British Palæozoic Fossils in the Camb. Museum, p. 418, pl. iii D, fig. 27, 1855.

— TRIANGULARIS, *Semenow*. Ueber die Fossilien des Schlesischen Kohlenkalkes, 1854.

*Spec. Char.* Triangular, twice as wide as long, with a straight, elongated hinge-line, and slightly concave, nearly parallel-sided area, towards the attenuated extremities of which the lateral margins of each valve converge, forming acute angles with the hinge. The fissure is triangular, and partly covered by a pseudo-deltidium. The dorsal valve is less convex than the opposite one, with an elevated mesial fold, which commonly assumes the character of a single produced and acutely angular cuneiform ridge or rib, at times considerably prolonged beyond the frontal level of the lateral portions of the valve. On either side of this central ridge from six to ten smaller ribs ornament the lateral portions of the valve. The beak of the ventral valve is narrow, produced, and incurved. A shallow mesial sinus commences at the extremity of the beak, and extends to the front; but at a short distance from its origin a mesial or central rib originates, which becomes wider and more elevated and produced as it approaches the front, and corresponds with the central ridge of the dorsal valve. Seven to eleven smaller ribs exist also on the lateral portions of the valve, on either side of the sinus. The dimensions taken from a perfect individual have produced—

Length $10\frac{1}{2}$, width $21\frac{1}{2}$, depth $6\frac{1}{2}$ lines.

*Obs.* This elegant shell was first described and figured by Martin, from a specimen which, at a subsequent period, became the property of the late J. Sowerby, and of which he gave a somewhat restored illustration in the 'Mineral Conchology.' Through the kindness of Mr. J. de C. Sowerby, I am myself enabled to portray this individual (figs. 16, 17), so that there can exist no doubt as to the identity of the original type. I have said so much to be able to prove that Professor M'Coy was decidedly mistaken when, in 1844 and 1855, he considered his so-termed *Sp. ornithorhyncha* to be distinct from Martin's species;[1] for, after a careful inspection of the last-named author's type (fig. 23), it will be easily seen that the only visible difference between it and Martin's specimen consists in the more or less developed condition of the mesial ridge in either valve. Martin's specimen clearly shows the ridge that originates in the sinus of the larger valve, so characteristic a feature of his species. *Sp. triangularis* appears to be a rare fossil, both in Great Britain and on the Continent, the only perfect example I have been able to examine being the one in the possession of Mr. Reed, of York (figs. 18—21). It here also assumes much of the cruciform aspect described by Professor M'Coy, and is intermediate

[1] Professor De Koninck allows me to state that he entirely coincides in the view here expressed.

in character between Martin's specimen and that figured by Professor M'Coy. The number of ribs also varies a little in different individuals.

This shell was well described and figured in 1843 by Professor De Koninck, in his excellent work on Belgian Carboniferous fossils, and through that gentleman's kindness I have been able to examine the very few individuals he could obtain from the quarries of Visé. M. De Koninck states that "this shell, whose denomination sufficiently denotes the shape it usually assumes, is, above all, characterised by the singular conformation of its sinus, to which no attention has been paid by the authors who have described it. This sinus is smooth, and presents nothing particular in young individuals; but when they have acquired half their growth, a small ridge appears, which becomes wider with age, and is never absent in the numerous varieties under which this species presents itself, and of which we have figured the most dissimilar shapes," &c.

The surface of the valves is ornamented, in addition to the ribs, by numerous concentric lines of growth, which become the more approximate as they approach the margin of the valves. I have, through the kindness of Dr. Griffith and Professor Sedgwick, been enabled to examine the original examples on which Professor M'Coy founded his *Sp. ornithorhyncha*, and to compare them with Martin's specimen of *T. triangularis*. Professor Phillips's figure, in the 'Geol. of Yorkshire,' vol. ii, pl. ix, fig. 12, is larger than any example I have seen, and cannot be considered a characteristic representation of the species.

*Loc.* This shell was obtained at Buxton by Martin. It occurs also in Derbyshire; at Settle, in Yorkshire; at Bolland, Kirkby Lonsdale, &c. Professor M'Coy's specimens were from Millecent (Clare), Ireland. I have not seen any Scotch specimens.

SPIRIFERA TRIGONALIS, *Martin*. Plate V, figs. 25—34; 35—37?

CONCHYLIOLITES ANOMITES TRIGONALIS, *Martin*. Pet. Derb., tabl. xxxvi, fig. 1, 1809.
SPIRIFER TRIGONALIS, *Sowerby*. Min. Con., tab. 265, fig. 1 (not 2 and 3), 1820.
SPIRIFERA TRIGONALIS, var. *a*, *M'Coy*. British Palæozoic Fossils, p. 423, 1855.

*Spec. Char.* Transversely trigonal; hinge-line almost as long, or a little longer, than the width of the shell, the lateral angles being either rounded off or acute, and slightly prolonged. Area sub-parallel, of moderate width, and divided by a triangular fissure, covered in part by a pseudo-deltidium. Beak rounded, moderately produced, and incurved; valves almost equally convex; the mesial fold in the dorsal valve is elevated, angular, and extended beyond the level of the lateral portions of the valve; it is, in general, divided by three principal ribs, of which the central one is at the same time the largest and most extended. In the ventral valve the sinus is deep, and likewise divided by three longitudinal ribs, the central one being (as in the dorsal valve) the most developed.

In addition to these, the surface of each valve is ornamented by from twenty to twenty-two simple ribs. The dimensions, taken from two examples, measured—

Length 11, width 13½, depth 8 lines.

„ 15, „ 18, „ 10 lines.

*Obs.* Martin states that "the general form or outline of this shell is trigonal or three-cornered, with the angles rounded off (our fig. 25); its surface longitudinally furrowed and sinuated; the furrows rounded, their number varying from twenty to thirty; the sinus continued, rounded, and extending the breadth of three or four furrows, hence striated like the other parts of the surface," &c. The species was not sufficiently illustrated, which has led subsequent authors to combine with it other allied forms, so as to obscure its distinctive characters. Thus, for example, in tab. 265 of the 'Mineral Conchology,' fig. 1 alone would belong to Martin's shell, while figs. 2, 3, and 4 are referable to Sowerby's own *Sp. bisulcata*, a fact I was able to confirm from the close examination of type examples of each species.[1] I am quite ready to admit *Sp. bisulcata* to be a nearly allied form, but am not yet entirely convinced that Professor M'Coy is right while considering Sowerby's shell as a simple variety of that of Martin's. Both may be distinguished by differences in general shape, the mesial fold in *Sp. trigonalis* being much more elevated, angular, prolonged, and possessing fewer ribs than in *Sp. bisulcata*, where the fold is much flatter, or more regularly rounded. Its hinge-line is also more extended, and the contour of the shell more semicircular and less trigonal than in Martin's shell. Nor can I agree with Professor M'Coy when he places *Sp. rhomboidea*, Phillips, among the varieties of the species under description.

Some young and exceptional examples of *Sp. triangularis* approach much to *Sp. trigonalis*, but in full-grown individuals the differences are well defined. The illustration attributed to *Sp. trigonalis* by Professor De Koninck, in his work on the 'Animaux fossiles de la Belgique,' pl. xvii, fig. 1, does not convey an adequate idea of Martin's species, to which in all probability it does not belong. I agree with Professor M'Coy that Eichwald's *Sp. incrassata*, as figured in the 'Geol. of Russia,' pl. vi, fig. 3, may be referred to *Sp. trigonalis*, but De Verneuil's *Sp. Strangwaysi*, fig. 1 of the same plate, is not equally certain.

*Loc.* This species is very abundant in the lower Carboniferous limestone of many British localities. Martin's type was derived from Derbyshire. Mr. Tate has it from Denwick and several other localities in Northumberland. It is found at Buxton. At Bakewell, in Derbyshire, several beautiful examples were obtained by Mr. Binney, from a

[1] Professor M'Coy seems to have hesitated to admit as *Sp. trigonalis* the above-named figures published by Sowerby, for we find stated, at p. 424 of the work on the 'British Palæozoic Fossils'—"I have not quoted Sowerby's figures ('Min. Con.,' tab. 265), as he gives no definition to the mesial ridge, and makes the ribs so much broader than any of the great number of specimens I have examined, that it is scarcely recognisable as a portrait of the ordinary forms." Professor M'Coy's description of Martin's shell is both detailed and correct.

cherty Carboniferous limestone, in which the spirals were beautifully preserved, while the internal casts exhibit the muscular and ovarian impressions (figs. 26, 27). It is also common, in this shape, in a yellow sandstone near Richmond, in Yorkshire, as well as Kendal. It abounds in the dark Carboniferous limestone of Lowick, and at Dent, in Yorkshire. It is not rare in Scotland, it is found at Courland, near Dalkeith; at Dryden; and Braidwood, near Carluke; and is also mentioned from several Irish localities.

SPIRIFERA BISULCATA, *Sowerby*. Plate IV, fig. 1? Plate V, fig. 1; Plate VI, figs. 1—19; Plate VII, fig. 4.

SPIRIFER BISULCATUS, *J. de C. Sowerby*. Min. Con., tab. 492, figs. 1 and 2, 1825.
— TRIGONALIS, *Sowerby* (not *Martin*). Min. Con., tab. 265, figs. 2 and 3, 1820.
— BISULCATUS, *Davreux*. Const. Geog. de la Province de Liege, p. 272, pl. vii, fig. 3, 1831.
— — *De Koninck*, Animaux fossiles de la Belgique, pl. xiv, fig. 4, 1843.
*Phillips*. Geol. of Yorkshire, vol. ii, pl. ix, fig. 14, 1836.
— SEMICIRCULARIS, *Phillips*. Ibid., pl. ix, figs. 15, 16.
— CALCARATA, *M'Coy* (not *Sow.*) Synopsis of the Carb. Foss. of Ireland, p. 130, pl. xxi, fig. 3.
— TRIGONALIS, var. BISULCATA and SEMICIRCULARIS, *M'Coy*. British Palæozoic Fossils, p. 424, 1855.

*Spec. Char.* Semicircular or sub-rhomboidal, commonly wider than long, with valves almost equally convex. The hinge-line is, in general, longer than the greatest width of the shell, the cardinal extremities being rounded, or forming angles of variable projection. Area moderately wide, divided by a triangular fissure, which is closed in part by a pseudo-deltidium. Beaks incurved, and at times considerably approximate. The sinus presents a moderate depth; the mesial fold, regularly rounded, is not much elevated, nor does it project to any extent beyond the level of the lateral margins. Each valve is ornamented by from thirty to forty obtusely rounded ribs; these are simple, and rarely bifurcated, but increase occasionally by intercalations at various distances from the beaks. The ribs on the mesial fold are arranged into three groups, separated by sulci of greater depth. Dimensions very variable—

Length 15½, width 18, depth 13 lines (Sowerby's type).
„ 24, „ 41, „ 20 lines (a very large individual).

*Obs.* This common Spirifer is so variable in its general shape, as well as in the number and width of its ribs, that it is not always easily separated from certain excep-

tional individuals of two or three approximate species. It is, however, distinguished from *Sp. trigonalis*, with which it has been often confounded, by the characters of its mesial fold, which does not project much beyond the level of the lateral margins, and is also regularly rounded, and not acutely elevated as in Martin's shell.

Professor M'Coy considers the form under description to be a simple variety of *Sp. trigonalis*, and states that "the most distinctive character of this variety (*bisulcata*), besides its gibbosity, is the abrupt rising of the mesial sinus at the margin, nearly at right angles to the plane of lateral edges, shortening the length of the middle of the ridge, notching the front margin, and giving a nearly semicircular curve to the profile of the receiving valve," &c.

It is distinguished from *Sp. mosquensis* and *striata* by the simplicity of its ribs, and from the Devonian *Sp. aperturata*, to which it has been assimilated, by the greater depth of the sinus, as well as the elevation of the fold of Schlotheim's species. Sowerby's type, which I have illustrated from the original specimen (Pl. VI, figs. 6 to 9), is very gibbous, and much less transverse than is the case with a vast number of individuals of the species, which also present wing-shaped expansions of greater or lesser extension, as may be seen from the series of examples which have been selected for illustration. It seems rather surprising that Sowerby did not perceive that the specimens, tab. 565, figs. 2 and 3 (13 and 14 of our plate), did belong to his species, and not to *Sp. trigonalis* to which he refers them, a mistake subsequently copied by various authors.

*Sp. semicircularis*, Phillips, does not seem to possess any characters distinguishable from *Sp. bisulcata*, and I have therefore followed Professor De Koninck in adding the name to the synonyms of the species under description.

The most remarkable peculiarity in *Sp. bisulcata* is the tendency of the ribs on the mesial fold to divide into three distinct groups, separated by sulci of greater depth; and although this may be also observed at times in other Spirifers, such as on some young examples of *Sp. striata*, still it is nowhere better exemplified than in the shell under description. *Sp. bisulcata* appears to have attained much larger dimensions than any example of *Sp. trigonalis* I have hitherto examined.

The shell figured as *Sp. calcarata* by Professor M'Coy, in the 'Synopsis,' pl. xxi, fig. 3 (Pl. VII, fig. 4, of our plates), does not belong to the species so named by Sowerby: it is probably a malformation of *Sp. bisulcata*. The fine specimen, Pl. IV, fig. 1, seems likewise referable to one of the forms of Sowerby's variable species, and *Sp. transiens*, M'Coy, may also, perhaps, be an allied form; but as the original specimen is no longer to be found in Dr. Griffith's collection, and knowing of no other individual, there may exist some doubts as to the correctness of this last supposition.

*Loc.* Sowerby's original specimens are said to be from Dublin and Derbyshire; it occurs abundantly in several localities of the last-named county, such as at Dovedale; is also common in the Wensleydale and Yorkshire districts, at Lowick, Northumberland, in the Isle of Man, &c.

In Scotland it is found at Gare, Barrhead, Craigenglen, and Dallmellington, Dumfriesshire, &c. In Ireland it is said to occur near Dublin, at Ballintrillic, and Millecent. M. De Koninck mentions Visé, Chokier, and Ratingen among the foreign localities.

SPIRIFERA TRANSIENS, *M'Coy*.[1] Plate IV, fig. 2.

SPIRIFERA TRANSIENS, *M'Coy*. Synopsis of the Carboniferous Fossils of Ireland, p. 135, pl. xix, fig. 14, 1844.

"*Spec. Char.* Triangular or rhomboidal, including the beak, twice as wide as long, gibbous; mesial fold very large, prominent, rounded, undivided, producing a very deep sinus in the front margin; sides radiated, with about ten or twelve large, thick, rounded ribs, equal or irregularly duplicate; mesial fold with about six or seven ribs, equal in size to those of the sides; cardinal angles acute; cardinal area low, triangular.

"This species is nearly allied to *Sp. grandæva* of the Devonian rocks, but is distinguished by its very large, undefined mesial fold, and more tumid sides. It differs from *Sp. bisulcata* and *Sp. attenuata* in its very large, undefined mesial fold, and the smaller number and greater size of its radiatory ribs, and most importantly by the cardinal area, as in *Cyrtia*. Length one inch seven lines, width two inches six lines. Young specimens are not so wide in proportion to the length ('Synopsis,' p. 135)."

Mr. Kelly states that it is abundant at Clonalvy, Ireland.

SPIRIFERA GRANDICOSTATA, *M'Coy*. Plate V, figs. 38, 39; Plate VII, figs. 7—16.

SPIRIFERA GRANDICOSTATA, *M'Coy*. Annals and Mag. of Nat. Hist., 2d series, vol. x, 1853; and British Palæozoic Fossils in the Cambridge Museum, p. 417, pl. iii D, fig. 29, 1855.

*Spec. Char.* Transversely sub-rhomboidal or obtusely triangular; hinge-line as long or longer than the greatest width of the shell; the lateral margins are regularly curved until they reach the extremities of the hinge-line, or are abruptly attenuated towards the cardinal angles, so as to produce acutely prolonged extremities; valves moderately convex. The area, with sub-parallel sides, is divided by a rather wide triangular fissure. Beak small, incurved, and but slightly produced. The four or five ribs which ornament the mesial fold are, in general, smaller and less defined than those which cover the lateral portions of the shell; the last, varying from ten to twenty-four on each valve, are very large, and either

[1] From not having been able to procure any example of this species, I am compelled to reproduce the description taken from the 'Synopsis.'

simple, or here and there bifurcated, or trifurcated near the margin. The sinus is of moderate depth. The measurements taken from two examples have produced—

Length 20, width 34, depth 14 lines.
„ 12, „ 22 „ 11 lines.

*Obs.* Few species seem to be more variable in shape and character than the one I am now describing, and it was only after considerable hesitation—and the examination of a vast number of specimens—that I could make up my mind to consider the extreme forms delineated in Pl. VII, figs. 7—16, as belonging to a single species, viz., *Sp. grandicostata*, and of which I have also reproduced the original illustration (Pl. V, figs. 38, 39). In the single representation given by the author of ('British Palæozoic Fossils') the lateral margins are abruptly attenuated, as in some of the figures in my Pl. VII, but this is not the constant peculiarity of the larger number of individuals, in which the cardinal extremities are not extended to the same extent as in the representation of the original type. It is further observed by Professor M'Coy that "this shell is allied to *Sp. trigonalis* of Martin, but differs from it by its abruptly narrowed and attenuated sides, and by its few very large angular ribs occupying the body of the shell, and the abrupt diminution in size of the five or six outer ridges on each side. A very young specimen, nine lines wide, has the three ridges in the mesial hollow distinctly marked, but nearly as large as the lateral ones, of which there are three or four great ones on each side, but scarcely a trace of any additional ones on the flattened cardinal angles, which are strongly striated parallel to the angles." I may here observe that, although I have observed the apparent diminution in width of the five or six outer ribs alluded to, they are far from being so in the greater number of specimens, in which the ribs gradually diminish in width and dimensions from either side of the mesial fold, as in most other species of Spirifer. The proportion and dimensions of the ribs on the mesial fold is also very dissimilar in different individuals, but in no case have I observed them as large as upon the lateral portions of the valves. Professor De Koninck, to whom I have forwarded a proof of my plates, thinks that perhaps the shells in question might belong to *Spirifer Kelhavii* (V. Buch) found at Bear Island, and published in the 'Memoirs of the Academy of Sciences of Berlin,' in 1846; but the shell there delineated is so very much more elongated than any British example I have seen, that I should not feel myself authorised to attribute to it our English shells without having been able to examine some specimens of the Prussian author's species.

*Loc.* Professor M'Coy states that his specimens (now in the Cambridge Museum) are from Derbyshire; it abounds at Park Hill, Longnor, whence a beautiful series may be seen in the Museum of the Geological Survey, as well as the British Museum; and I have received the loan of several fine examples obtained at Bolland and the Isle of Man, from Messrs. E. Wood, Parker, and Muschen, and the Rev. Dr. Cumming. Professor M'Coy states the shell to be common in the Irish limestone at Ardagh. It has often been erroneously labelled *Sp. triangularis* in various collections.

SPIRIFERA CONVOLUTA, *Phillips*. Plate V, figs. 2—15.

SPIRIFERA CONVOLUTA, *Phillips*. Geol. of Yorkshire, vol. ii, p. 217, pl. ix, fig. 7, 1836.
— RHOMBOIDEA, *Phillips* (?). Ibid., figs. 8, 9.
— CONVOLUTA, *De Koninck*. Animaux foss. de la Belgique, p. 247, pl. xvii, fig. 2, 1843.
— — *M'Coy*. Synopsis of Carb. Foss. of Ireland, p. 130, 1844.

*Spec. Char.* Fusiform, three or four times as wide as long, with a straight hinge-line, to which the lateral margins of each valve rapidly converge, producing acute angles at the extremities. Area rather narrow, and parallel-sided, with a triangular fissure partly covered by a pseudo-deltidium. Beak small, and but slightly produced beyond the cardinal edge. Ventral valve a little more convex than the dorsal one, with a sinus of variable depth and width, and which corresponds in the small valve with a mesial fold at times considerably elevated above the general convexity of the valve, and to which is due the strong frontal wave observable in some examples. Each valve is ornamented by from thirty to forty simple or intercalated ribs of unequal width, three or four of which occupying the mesial fold and sinus. Full-grown examples measured—

Length 11, width 45, depth 9 lines.
„ 14, „ 36, „ 15 lines.

*Obs.* This species is easily distinguished from other Carboniferous Spirifers by its great width compared to its length, which gives to the shell much the appearance of a weaver's spindle. The ribs in adult individuals are often much contorted and irregular in their width, as may be seen in specimens figs. 9 and 12. Professor Phillips represents a specimen in which one of the wings was imperfect. This I have replaced in the more correct illustration of the same example, fig. 9; here, as in fig. 12, the mesial fold has but little elevation above the general convexity of the valve; but in another of Professor Phillips's type specimens in the British Museum, as well as in one (figs. 14 and 15) belonging to the Royal Dublin Society, the mesial fold is considerably elevated. Professor De Koninck has published a very good description and illustration of this species, and mentions that in the young specimens the shell is far from presenting so extreme a transverse shape as it afterwards assumed. The lines of growth on the specimens from which figs. 9 and 12 were drawn denote that, while the length was $3\frac{1}{2}$ lines, the width did not exceed 9, and others seem to have been still less transverse. Professor De Koninck is also of opinion that *S. rhomboidea* (figs. 2—8) and *S. fusiformis*, Phillips, cannot be considered distinct from *S. convoluta*, and proposes to place both names among the synonyms. Having been able to study numerous examples of *S. rhomboidea*, I feel disposed to agree so far with my learned friend, while refusing to the last-named shell a separate specific value. The name may, however, perhaps be retained as a varietal denomination for *S. convoluta*, in which the ribs on the mesial fold are less defined than on

the lateral portions of the valve; it is also rather more rhomboidal, and in some examples the sinus is less excavated towards the front than is the case with typical examples of the species under description.[1] M. Semenow adopts Professor De Koninck's views on this subject; but in order that each person may be better able to form his own opinion, I may here mention that figs. 2 to 8 represent what Professor Phillips considers his *Sp. rhomboidea*, while 9 to 15 are types of *Sp. convoluta*. There would, however, exist some risk in adopting Professor De Koninck's supposition relative to *Sp. fusiformis*, from the fact that the original type specimen of this species, now in the British Museum, is smooth, and not ribbed, as Professor Phillips's illustration would seem to imply. Lastly, M. De Koninck further observes that "it is very probable that Martin may have created his *Anomites acutus* (figs. 5 and 6 of our Pl. VII) on a similar specimen (*Sp. rhomboidea*)," but I do not consider we have sufficient grounds for this supposition. Martin's figure has been so differently interpreted, and there appears to exist so much doubt as to the species to which it really belongs, that I have considered it preferable to completely erase the name from the nomenclature, than to continue to discuss a matter on which no certain conclusions can be arrived at.

*Loc.* Bolland and Kildare are given by Phillips as the localities whence his specimens were derived. Mr. Parker has it from Clitheroe Quarry, Lancashire, and it is also found at Visé, in Belgium. The var. *rhomboidea* seems to be more abundant.

### Sriripera laminosa, *M'Coy*. Plate VII, figs. 17—22.

Spirifer hystericus, *De Koninck*. Animaux fossiles de la Belgique, p. 236, pl. xv, fig. 3, 1843 (not of *Schlotheim*).

Cyrtia laminosa, *M'Coy*. Synopsis of the Carb. Fossils of Ireland, p. 137, pl. xxi, fig. 4, 1844.

— speciosa, *M'Coy*. Synopsis, p. 134 (not of *Schlotheim*).

Spirifer tricornis, *De Koninck*. Animaux fossiles de la Belgique (Supplement), p. 657, 1851.

— laminosa, *M'Coy*. British Palæozoic Fossils, p. 426, 1855.

*Spec. Char.* Transversely sub-rhomboidal; valves unequally convex, the ventral one

[1] Professor Phillips's description in the 'Geol. of Yorkshire,' vol. ii, p. 217, is as follows:

"*Sp. rhomboidea*, pl. ix, figs. 8, 9, Bolland, Ireland.

"Width fully double the length, extremities sub-cylindrical, cardinal area very wide, mesial fold defined; surface radiated with obtuse smooth sulci. The great proportionate width of the cardinal area is a strong character, yet it very much resembles both *Sp. convoluta*, Ph., and *Sp. attenuata*, Sow., 'M. C.,' t. 562, but the ribs of that species are bolder and the mesial fold is different."

Professor Phillips also describes as follows his—

"*Sp. convoluta*, Phil., pl. ix, fig. 7, Bolland.

"Width four times the length; cardinal area concave, surface obtusely and unequally radiated."

by far the deepest. The lateral portions of the shell are regularly curved, forming, with the extremities of the hinge-line, acute, but not prolonged cardinal extremities; area large, triangular, more or less elevated, and divided by a fissure of moderate width. Beak small, not much produced above or beyond the level of the area. The mesial fold in the dorsal valve is broad, and more or less elevated, without ribs, and corresponding with a deep and rather wide longitudinal sinus in the ventral one. Each valve is ornamented by about twenty or twenty-two narrow radiating ribs, intersected by closely disposed, sharp, concentric, undulating laminæ. The measurements from two examples have produced—

Length 12, width 21, depth 10 lines.

„ 8, „ 11, „ $6\frac{1}{2}$ lines.

*Obs.* This beautiful shell was correctly described and illustrated by Professor De Koninck in 1843, but unfortunately under the mistaken denomination of *Sp. hystericus*, but which the same author replaced by that of *S. tricornis* in 1851. It had, however, been named *Sp. laminosa*, in 1844, by Professor M'Coy, a denomination we are bound to maintain; notwithstanding that the term is in itself hardly appropriate, from the fact that several other Carboniferous, Devonian, Silurian, and even Permian species, are similarly ornamented by scale-like imbricated laminæ. The illustrations of this shell, published in the 'Synopsis,' are so incomplete and unsatisfactory, that we can easily understand the doubts entertained by some of those who have not, like ourselves, had the opportunity of studying the Irish specimens; and I feel at a loss to divine the reason which could have tempted Professor M'Coy to place this and several other species into the sub-genus *Cyrtia*, with which it and they possess so little affinity. *Sp. laminosa* has some points of resemblance to *Spiriferina octoplicata;* but it is readily distinguished by the greater number of its ribs.

In our British localities the shell under description is more often found with its valves disunited; the mesial fold not extending, in general, beyond the level of the lateral portions of the valve; but in some exceptional examples preserved in the Cambridge Museum, this portion of the shell "is produced in front into a long tongue-shaped flattened lobe" (figs. 21, 22), as was observed by Professor M'Coy in his work on 'British Palæozoic Fossils.' The specimens described in the 'Synopsis' under the name of *Sp. speciosa* undoubtedly belong to *Sp. laminosa*, an opinion in which Mr. Salter fully concurs.

*Loc.* It is stated by Professor M'Coy not to be uncommon in Derbyshire; Mr. Tate has the shell from Denwick, Northumberland; Mr. Howse from Redesdale. In Ireland it is said to occur at Stridagh Point, Malahide, Hook, Abbey Bay, Ballintrillic, and Ballyshanns, from most of which localities I have been able to examine examples, through the kindness of Dr. Griffith. It is not rare at Tournay; and has been found, although less commonly, at Visé and in other Belgian localities, by Professor De Koninck.

SPIRIFERINA CRISTATA, *var.* OCTOPLICATA, *J. de C. Sowerby.* Plate VII, figs. 37—47.

SPIRIFER OCTOPLICATUS, *Sowerby.* Min. Con., p. 120, pl. 562, tabs. 2, 3, 4, May, 1827.
— CRISTATUS, *V. Buch.* Ueber Delthyris, p. 39, 1837.
— — *M'Coy.* Synopsis of the Carb. Foss. of Ireland, p. 133; and British Palæozoic Fossils, p. 418, 1855.

*Spec. Char.* Transversely sub-rhomboidal, valves about equally convex, and at times rather gibbous; hinge-line as long as the greatest width of the shell. Cardinal angles acute or slightly rounded; area concave, triangular, and of variable width, fissure partly covered by a pseudo-deltidium; beak small and incurved. The mesial fold of the dorsal valve is more often composed of a single rib which is much larger than those situated on the lateral portions of the shell; its crest being in general rounded from the umbone to about half its length, when it gradually becomes more and more flattened as it approaches the frontal margin (fig. 38), but at times it remains angular during its entire length, with a tendency to the formation of a rudimentary plait on either of its slopes, so that in these rarer cases the fold assumes towards the front an obscurely triplicated appearance (fig. 37). The sinus in the ventral valve is deep, acute, and generally simple, but also more rarely interrupted by a rudimentary rib, which becomes visible in the proximity of the front.

The valves are ornamented by from eight to twelve angular ribs, which are, as well as the sinus and fold, intersected by closely disposed, concentric, scale-like laminæ. The surface of the shell is also closely beset by numerous small granular (spinose) asperities; the shell-structure being likewise perforated by minute tubuli or perforations.

In the interior of the ventral valve there exists a sharp elevated mesial septum, which rises from the bottom of the valve, and partly divides the spiral cones. Dimensions very variable. Three examples, of which the first two are Sowerby's original types, have afforded the following measurements:

Length 9, width 13, depth 8 lines.
„ 6, „ 11, „ 6 lines.
„ 5, „ 8, „ 5 lines.

*Obs.* The shell under description seems to have been mistaken and misunderstood by the various authors who have commented upon its characters and affinities. It is very variable in shape, and but rarely possesses the definite number of ribs which its name would imply. The area is also very variable in its dimensions as well as in the angle it forms with the level of the smaller valve, as may be seen from a glance at figures 41 and 43. Its affinities with the Permian *Sp. cristata* of Schlotheim ('Akad. Münch.,' vol. vi, p. 28, pl. i, fig. 3, 1816) did not escape the notice of Baron Von Buch in 1837,

nor that of Professor King in 1849, for we find stated at p. 128 of his work on 'British Permian Fossils,' "*Trigonotreta cristata* closely resembles one or more so-called species found in the Carboniferous and other formations, particularly *S. octoplicata* of J. Sowerby. Having examined in Mr. J. de C. Sowerby's collection the originals (from Derbyshire) of the figures in the 'Mineral Conchology,' the only difference I could perceive is that they are wider than any examples which have occurred to me of the present species. The specimens bearing the name of *Sp. insculpta*, in the Gilbertson Collection of the British Museum, appear to be undistinguishable from *Trigonostrata cristata*. The Jurassic fossil, which Zieten has identified with *T. octoplicata*, is another closely analogous species."

In 1843, Professor De Koninck had placed Sowerby's *Sp. octoplicata* ('M. C.,' tab. 562, figs. 2 and 3 only) with a mark of doubt among the synonyms of *Sp. cristata*,[1] while fig. 4 of the same author's plate was considered by him to be referable to the *Sp. crispus*; but the examination of Sowerby's three examples will convince any observer that they belong to a single species. The Belgian author further remarks that according to M. De Buch, *Sp. cristata* would possess but four ribs on each side of the sinus, while our Carboniferous one possesses a much larger number; this being the only difference he was able to discover, and which did not appear to him of sufficient importance to warrant a separation of the two shells. However, in the Supplement to the great work on the 'Carboniferous Fossils of Belgium,' M. De Koninck retracts his former identification, adding that the Carboniferous shell was distinct and distinguishable by its larger number of ribs.

In 1855 we find Professor M'Coy refuting the inferences published by the author of the Permian monograph; he states, "Professor King mentions that the only differences he could perceive between this species (*Sp. cristata*) and *Sp. octoplicata* is the greater width of the latter; but I observe that specimens of the latter have a proportionately much lower cardinal area, longer hinge-line, and are of nearly double the average size, and have five or six lateral plaits on each side of the mesial sinus, which are comparatively so small, that at the margin three of them would be required to equal the mesial ridge in width, while in the present species the mesial ridge is little wider than the adjoining lateral ones. The Carboniferous *Sp. insculpta*, Phillips, seems also to him to be undistinguishable from the Permian *Sp. cristata*; but besides the greater height of the cardinal area, I have never seen more than one or two lateral ribs on each side of the median one, and the punctuations seem slightly closer." From the statements above recorded it will be perceived how very dissimilar are the opinions entertained respecting the affinities of the form under description.

Having been able to assemble, through the kindness of many zealous friends, a vast number of both the Permian and Carboniferous shells above mentioned, comprising the original specimens illustrated by the author of the 'Mineral Conchology,' I have been able

[1] 'Animaux fossiles de la Belgique,' p. 211.

to institute between them a minute and searching comparison, which enables me to substantiate to a large extent the opinion expressed by Baron Von Buch and Professor King as to the close resemblance existing between the Carboniferous and Permian shells, and to declare that, in my humble opinion, *Sp. octoplicata* cannot claim to be considered more than a variety of *Sp. cristata*.[1]

The discovery lately made by Mr. Kirkby, at Tunstall Hill, of a magnificent and unusually large example of Schlotheim's species (first illustrated by Mr. Howse in the 'Annals of Nat. Hist.,'[2] and subsequently more fully so, during the same year, in Pl. II, fig. 43, of our Permian illustrations), places this matter beyond even the range of doubt; for, with the dimensions of 5 lines in length, $9\frac{1}{2}$ in width, and 5 in depth, a mesial fold, of which the crest is depressed towards the front, and fourteen ribs on each valve, it presents all the characters and appearances of several of Sowerby's type examples, from which it is distinguished only by the light-yellow colour peculiar to our Permian fossils. I feel, therefore, disposed to maintain for the Carboniferous shell the varietal designation of *octoplicata*, to distinguish it from Schlotheim's type, which is, in general, of smaller dimensions, with a minor number of plaits. The variety *octoplicata* has likewise shown a tendency to triplication in the mesial fold, which I have not hitherto observed on any of the numerous individuals of the Permian shell that have passed under my notice. From *Sp. laminosa* the shell under description is easily distinguished by its less numerous, comparatively larger, and more angular ribs; from *Sp. insculpta* (a closely allied form) by the greater disproportion of the mesial plait relative to the lateral ones, which are, at the same time, more numerous and smaller in Sowerby's shell. I am still uncertain whether *Sp. minima* (Sowerby) and *Sp. partita* (Portlock) should be considered as specifically distinct, or forming part of the variety of *Sp. cristata*. The material in my possession has not been sufficient to allow me to determine that point satisfactorily.

*Loc.* Sowerby mentions his specimens as having been derived from Derbyshire. Gare, Lanarkshire; Dr. Fleming has examples from Westlothian, Scotland; and a fine Irish series from Hook Point and the shores of Lough Hill, county of Sligo, may be studied in the Museum of the Geological Society. Professor M'Coy mentions the shell from Flintshire, and Mr. Kelly quotes Bundoran, Carrowmably, and Cregg, Ireland. It has also been found in several foreign localities.

SPIRIFERINA MINIMA, *Sowerby*. Plate VII, figs. 56—59.

SPIRIFER MINIMUS, *Sowerby*. Min. Con., p. 105, tab. 377, fig. 1, Nov., 1822.

*Spec. Char.* Rhomboidal, a little wider than long; hinge-line rather shorter than the

[1] As *Sp. octoplicata* was first introduced into existence, and therefore the oldest form, it is in reality the type of which *Sp. cristata* would be the variety, but the law of priority as to names obliges us to retain Schlotheim's in preference.

[2] Vol. xix, 2d series, pl. iv, figs. 5 and 6, 1857.

greatest width of the shell, cardinal angles rounded; valves moderately convex; area triangular, rather elevated; fissure large; beak small and incurved. Each valve is ornamented by from seventeen to twenty-three radiating ribs, of which three smaller ones occupy the mesial fold of the dorsal valve, which is but moderately elevated, and longitudinally flattened along its middle. In the ventral valve the sinus is rather deep, and exhibits also two or three smaller ribs. The frontal wave is strongly marked; the ribs are intersected in both valves by concentric laminæ of growth. The dimensions of Sowerby's two original examples have given—

Length 7, width 8, depth 6 lines.

„ 6, „ 7, „ $4\frac{1}{2}$ lines.

*Obs.* The only specimens I have been able to examine are those figured in the 'Mineral Conchology,' and from such scanty material I would hardly consider myself warranted to offer any decided opinion as to their specific claims. After comparing the specimens with the originals of *S. octoplicata*, the differences consisted in the last-named shell being larger and more transverse, with fewer and bolder ribs; there exists also a dissimilarity in the character of the mesial fold, which is, in *S. minima*, much flatter and more regularly divided into three flattened ribs, than in any examples of true *octoplicata* that have passed under my notice. It is, therefore, probable that after a more extended examination of a larger number of specimens these slight differences may be considered valueless, and that it may be found desirable to add it also to the varieties of *Sp. cristata* of Schlotheim.

Professor M'Coy is, however, mistaken when he describes the shell under description as possessing an angular mesial fold or ridge, this last being most distinctly flattened in the two original examples preserved in the collection of Mr. J. de C. Sowerby, and which I have drawn afresh under figs. 56 and 59 of my plate. For similar reasons I must object to the identification of the shell in question, as proposed by Mr. Morris,[1] with *Anomites acutus* of Martin, which seems to me much more probably the young of some other species.

*Loc.* Sowerby's specimens were obtained, along with others of *Athyris ambiguus*, in decomposed limestone near Bakewell; the shell being silicefied.

SPIRIFERINA (?) PARTITA, *Portlock*.[2] Plate VII, figs. 60, 61.

SPIRIFERA PARTITA, *Portlock*. Report on the Geology of the County of Londonderry, Tyrone, and Fermanagh, p. 567, pl. xxxviii, fig. 3, 1843.

"*Spec. Char.* A small shell, 2″ long and 35″ wide; dorsal valve (*our ventral one*) with

[1] 'A Catalogue of British Fossils,' p. 150, 1854.

[2] Not having been able to procure a specimen of the above-named shell, and as the description and illustrations are not sufficiently detailed to allow of my forming a positive opinion as to its specific claims and affinities, I have preferred to simply reproduce Colonel Portlock's description and figures.

a deep sinus extending to the beak, and in the casts marked by a central linear furrow; the ventral valve (*our dorsal one*) with a rounded central rise marked in the centre by a linear furrow approximating it to *Sp. pingens*. The sulci between the central plait and the lateral costæ strongly marked; the number of the lateral costæ variable, being sometimes three and at other times six on each side; the general form rounded, appoaching to that of *Sp. speciosa*."

*Loc.* Kildress, Ireland.

SPIRIFERINA (?) INSCULPTA, *Phillips*. Plate VII, figs. 48—55.

SPIRIFERA INSCULPTA, *Phillips*. Geol. of Yorkshire, vol. ii, p. 216, pl. ix, figs. 2 and 3, 1836.

— CRISPUS and HETEROCLYTUS, *De Koninck* (not *Linnæus* nor *Defrance*). Animaux fossiles de la Belgique, pp. 257 and 259, pl. xv, figs. 7, 8, and pl. xv *bis*, fig. 1, 1843.

— QUINQUELOBA, *M'Coy*. Synopsis of the Carb. Fossils of Ireland, p. 134, pl. xxii, fig. 7, 1844.

— KONINCKIANA, *D'Orbigny*. Prodrome, vol. i, p. 119.

— INSCULPTA, *Semenow*. Ueber die Fossilien des Schlesischen Kohlenkalkes, 1854.

— — *De Koninck*. Animaux fossiles de la Belgique (Supplement), p. 658, 1851.

*Spec. Char.* More or less semicircular, about one third wider than long; hinge-line straight, and as wide as the greatest width of the shell. Area large, triangular, and but slightly curved; fissure wide; beak very small, and not much produced above the level of the area. Valves almost equally convex. The ventral one is ornamented by five (rarely seven) large, bold, angular ribs, the central one exceeding the others somewhat in proportions, and corresponding with the deep angular sinus of the opposite valve. Six angular ribs exist on the ventral valve; these, as well as those on the dorsal one, being intersected by close, concentric laminæ of growth. Shell-structure minutely perforated. Dimensions taken from two individuals have produced—

Length 8, width 11, depth 6 lines.

„ $6\frac{1}{2}$, „ 11, „ 7 lines.

*Obs.* Phillips's short description and illustrations convey a clear idea of the adult or full-grown condition of the shell under description. Its few bold ribs distinguish it from *Sp. cristata* and its var. *octoplicata*, as well as from *Sp. minima* and *Sp. laminosa*. It has been taken for the *Anomia crispa* of Linnæus, as well as for the *Terebratulitis cristata* of Schlotheim, but seems specifically distinguished from both by the small difference that exists in the proportions of its central rib or plait relative to the lateral ones, which in the above-named species and varieties are much more disproportionate. *Sp. quinqueloba*

belongs undoubtedly to Phillips's *Sp. insculpta*, of which I was able to convince myself by the comparison of the original specimens of both, Professor M'Coy's very imperfect specimen having been kindly lent for the purpose by Dr. Griffith, of Dublin.

*Loc.* Professor Phillips obtained his examples from Bolland. Mr. Parker has it from the Clitheroe quarries, in Lancashire. The Geological Survey possesses a fine series, of different ages, from Yorkshire, and Longnor, Derbyshire. In Ireland it is found at Ardagh (Drumcondra). M. De Koninck mentions the shell from Visé and Tournay, in Belgium.

SPIRIFERA REEDII, *Dav.* Plate V, figs. 40—47.

*Spec. Char.* Longitudinally oval, valves almost equally convex; hinge-line shorter than the greatest breadth of the shell; lateral margins and cardinal angles rounded; area small, triangular, elevated; beak produced and incurved. Each valve is ornamented by from nineteen to twenty-three small, radiating ribs, of which the central one in the dorsal valve is rather wider, and a little more produced, than the lateral ones: to this corresponds a shallow, small, longitudinal sinus in the opposite valve. Dimensions taken from two examples have produced—

Length $9\frac{1}{2}$, width 7, depth $6\frac{1}{2}$ lines.

„ 5, „ 4, „ 3 lines.

*Obs.* I have been able to examine but three individuals of this little species, one adult (fig. 40), in the British Museum, and two younger shells (figs 43 and 47), in the possession of Mr. Reed, of York. They are distinguished from *Sp. sexradialis*, Phillips, by their larger number of ribs, smaller fold and sinus, and lesser width near the hinge-line.

*Loc.* Settle, Yorkshire.

SPIRIFERA DECEMCOSTATA, *M'Coy.*[1] Plate VII, fig. 23.

SPIRIFERA DECEMCOSTATA, *M'Coy.* Synopsis of the Carb. Fossils of Ireland, p. 131, pl. xxii, fig. 9, 1844.

"*Spec. Char.* Semicircular, gibbous, smooth, twice as wide as long; front rounded,

[1] The *single* and *imperfect* valve upon which this species was founded, was kindly lent to me by Dr. Griffith; but from such incomplete material it would be more than hazardous to decide as to its specific value. Under these circumstances I have preferred to simply reproduce the author's description, that the reader may have before him all that has been published on the subject. M. De Koninck informs me that he has found similar decorticated valves near Dinant, in Belgium, and seems inclined to refer *Sp. decemcostata* to *S. laminosa*, M'Coy; but the evidence does not permit my confirming the statement.

sides suddenly attenuate, cuspidate; mesial lobe large, round, projecting, with five large rounded ribs on each side, leaving a broad space at the cardinal angles smooth, or only striated transversely. This species is so very distinct from any other *Spirifera* with which I am acquainted, that it would be unnecessary to point out any peculiar difference. The whole surface is smooth except the cuspidate sides, which are marked with strong lines of growth."

*Loc.* Lower limestone, Millecent (Clare), Ireland.

SPIRIFERA CUSPIDATA, *Martin*, sp.[1] Plate VIII, figs. 19—24; Plate IX, figs. 1 and 2.

ANOMITES CUSPIDATUS, *Martin*. Trans. Linnean Soc., vol. iv, p. 44, pl. iii, figs. 1—4, 5, 6, 1796.
CONCHYLIOLITHUS ANOMITES CUSPIDATUS, *Martin*. Petref. Derb., tab. xlvi, fig. 34, and tab. xlvii, fig. 5, 1809.
SPIRIFER CUSPIDATUS, *Sowerby*. Min. Con., tab. 120, figs. 1, 2, 3, Feb., 1816.
CYRTIA SIMPLEX, *M'Coy*. Synopsis Carb. Foss. of Ireland, 1844 (not of *Phillips*).
— CUSPIDATA, *M'Coy*. British Palæozoic Fossils, p. 466, 1855.

*Spec. Char.* Transverse and pyramidal; hinge-line straight, in general rather shorter than the greatest width of the shell. The cardinal angles, formed by the junction of the lateral portions of the valves with the extremities of the hinge-line, are rounded off. *Dorsal* valve semicircular, moderately convex; mesial fold large, smooth, regularly convex, and elevated, with a slight longitudinal depression or groove (especially visible in casts) extending from the extremity of the umbone to about half the length of the fold. Each valve is ornamented by numerous small, simple ribs, varying from thirty to forty-four in number, according to age and individual, these being at the same time intersected by numerous concentric lines of growth. The ventral valve is pyramidal, much deeper than the opposite one, and possesses a large, wide, concave sinus, which extends from the extremity of the frontal margin, producing in front a strongly marked wave. Area very large, triangular, and acute, situated at a right angle to the general level of the dorsal valve; fissure large, but comparatively narrow in proportion to its length.

In the interior of the ventral valve a strong tooth exists on either side, at each extremity of the fissure. These are supported by dental plates, which diverge from the extremity of the beak, forming the fissure walls, and occupying about one third of the length of the bottom of the valve. The larger portion of the interior of the shell is

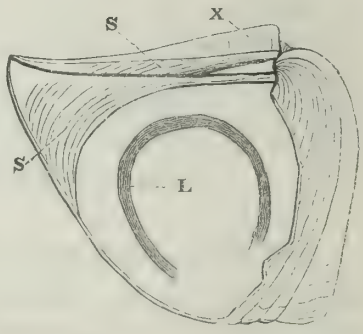
[1] This well-known Carboniferous fossil has been very often referred to and figured by various authors. By Parkinson (1811), Bronn (1824), Krüger (1825), Defrance (1827), Fleming (1828), Holl (1830), Keferst (1834), Deshayes *apud* Lamarck (1836), Phillips (1836), V. Buch (1837), Conrad (1838), &c., a full reference to which will be found in page 243 of Professor De Koninck's works on the Belgian Carboniferous Fossils.

occupied by the spiral cones, which were fixed in the usual manner to the projections of the inner socket walls of the dorsal valve. Two examples measured—

Length 2 inches, width 4 inches, depth 3 inches.

Length 2 inches 9 lines, width 2 inches 10 lines, depth 2 inches 5 lines.

*Obs.* The external characters of *Sp. cuspidata* were correctly described and illustrated by Martin as early as 1796, and but little has been added concerning its internal arrangements. Having, through the kindness of Mr. Kelly, obtained a certain number of Irish specimens, I fractured a few in order to ascertain more correctly the true position and dimensions of the dental or rostral shelly plates, which have already been described, and which will be found illustrated in the accompanying cut. It is quite evident that the shell under description belongs to the genus *Spirifer* proper, and not to the subgenus *Cyrtia*, as supposed by Professor M'Coy, and in which opinion I had coincided before having become fully aware of its complete internal arrangements. No specimen of *Sp. cuspidata* I have hitherto been able to examine has exhibited the deltidium in its entire condition, but which, in all probability, was not perforated by a circular foramen, as is seen in true types of the subgenus *Cyrtia*, such as in *C. trapezoidalis* and *C. Murchisoniana*. Nor do I perceive upon what grounds Professor M'Coy asserts that the fissure displays a deep-seated pseudo-deltidium.




*Spirifera cuspidata.*

*X.* Area. *S.* Dental or rostral plates. *L.* Coil of the spirals.

The position of the dental plates is defined on the exterior of the shell by two diverging lines (Pl. VIII, fig. 22 *s*) departing from the extremity of the beak, and are more clearly visible in those examples (by far the more numerous) wherein the shell is but imperfectly preserved. It was to compressed shells from the lower limestone of Black Rock (Cork), on which the ribs were almost obliterated, that Professor M'Coy identified the Devonian *Sp. simplex* of Phillips, a mistake which Mr. Salter and myself were able to correct from the inspection of the original examples so named, and kindly communicated by Dr. Griffith. Other species have also been inaccurately referred to Martin's shell; these will be found enumerated in Professor De Koninck's work on Belgian fossils.

Some varieties of *Sp. cuspidata* (fig. 20) have been referred to the Devonian *Sp. macroptera* of Hall, in which the area is narrower and less developed than is usually the case in typical examples of Martin's shell. These varieties occur plentifully in limestone and millstone grit, near Kendal, but at the same time present every intermediate link connecting those individuals with a narrow area to the typical form of the species under description. This fact was pointed out by Professor M'Coy, at p. 426 of his work on 'British Palæozoic Fossils,' but I do not perceive that there exists any proportional difference in the width of the fissure as described by the Professor, and many of the examples

are evidently malformations, the beak being twisted more to the one than to the other side, as well as otherwise misshaped. The regular convexity and smoothness of the mesial fold and sinus distinguish the species under description from *Sp. distans* of Sowerby, as will be shortly explained.

*Loc.* This species occurs plentifully in various localities, such as in the lower Carboniferous limestone of Castleton (Derbyshire), at Twiston (Lancashire), at Preston, Bolland, Settle, near Bristol, &c. Mr. Kelly mentions the shell from Lisnapaste, Millecent, Ballyduff, Malahide, Cork, &c., in Ireland. I have not yet seen any Scotch example. In Belgium it is found at Tournay, and in other Continental localities.

SPIRIFERA DISTANS, *Sowerby*. Plate VIII, figs. 1—17.

SPIRIFER DISTANS, *J. de C. Sowerby*. Tab. 494, fig. 3, May, 1825.
— — *Phillips*. Geol. Yorkshire, vol. ii, p. 217, 1836.
CYRTIA DISTANS, *M'Coy*. Synopsis of the Carb. Fossils of Ireland, p. 136, 1844.

*Spec. Char.* Very variable in shape and proportions, more often imperfectly rhomboidal and transverse, with unequal convex valves. Hinge-line as long as the greatest width of the shell. The dorsal valve is more or less convex, but not in general gibbous; semicircular, and somewhat indented in front. The lateral margins form a convex curve to within a short distance of the cardinal angles, where they are often prolonged with acute terminations. The fold is wide, and but little elevated, its upper surface being much flattened, with a longitudinal sulcus extending along its middle, either quite to the front, or soon becoming converted into a rounded central rib. The lateral portions of the shell, on either side of the fold, are ornamented by from fourteen to fifteen small, single, or bifurcated ribs. The *ventral valve* is much deeper than the opposite one; the area is triangular and variable in its proportions, as well as in its development; it either presents a large flat surface at right angles to the level of the dorsal valve, or is more or less concave and elevated, showing or not a portion of the beak above and beyond its angular termination. The fissure is narrow, and in great part covered by a convex pseudodeltidium. The sinus is of moderate depth, and, in general, exhibits along its centre a well-defined rib, which is larger than those which ornament both slopes of the sinus and lateral portions of the valve. In the interior of the ventral valve there exists two largely developed, diverging, dental or rostral shelly plates, which extend from the beak along the bottom of the shell to rather less than half its length. The dimensions are exceedingly variable, on account of the great difference in depth of the ventral valve, as may be perceived from the following measurements:

Length 13, width 18½, depth 13 lines (Sowerby's type).
„ 14, „ 21, „ 13 lines.
„ 9, „ 22, „ 14 lines.

*Obs.* Sowerby's description and illustration does not convey a complete idea of all the peculiarities of this interesting species. His figure represents only one of its numerous variations, as will be better understood by a glance at our plate than by any lengthened description. In it we have been able to illustrate those connecting shapes which unite and explain the great differences observable between such specimens as figs. 1, 15, and 16. *Sp. distans* is easily distinguishable from *Sp. cuspidata*, to which at times it bears some resemblance by the shape of its fold and sinus. In Martin's shell the fold is regularly convex, the sinus concave, without any ribs, while in Sowerby's species the fold is hardly produced above the level of the lateral portions of the shell, with a central longitudinal rib. The sinus is likewise more or less obscurely ribbed, with a mesial one of larger dimensions. The hinge-line is also much longer in proportion than in *Sp. cuspidata*, the fissure being likewise more narrow.

*Loc.* Sowerby's specimen is stated to have been obtained near Dublin. Mr. Kelly mentions Bundoran, Malahide, and Millecent as Irish localities. Professor Phillips found it at Bolland. I am not acquainted with any Scottish examples.

SPIRIFERA BICARINATA, *M'Coy*.[1] Plate VIII, fig. 18.

SPIRIFERA BICARINATA, *M'Coy*. Synopsis of the Carboniferous Fossils of Ireland, p. 129, pl. xxii, fig. 10.

"*Spec. Char.* Rhomboidal, width more than twice the length, very gibbous; sides cylindrical; mesial fold wide, smooth, concave on both valves, bounded on both valves by two large, rounded, entire ribs on each side; cardinal area with parallel sides, very wide and hollow. This curious species is easily recognised by the mesial fold being concave, and bounded by large keels *on both* valves.

"Length 8 lines, width 1 inch 6 lines."

*Loc.* According to Mr. Kelly, Millecent (Ireland).

[1] As the original example is no longer to be found in Dr. Griffith's collection, it would be hardly safe to express an opinion on a species of which the author was able to illustrate but a very unsatisfactory and insufficient fragment; I therefore simply reproduce the original description and illustration.

SPIRIFERA MESOGONIA, *M'Coy*.[1] Plate VII, fig. 24.

CYSTIA MESOGONIA, *M'Coy*. Synopsis of the Carb. Fossils of Ireland, p. 137, pl. xxii, fig. 13, 1844.

SPIRIFER MESOGONIUS, *De Koninck*. Animaux Fossiles de la Belgique (supplement), p. 660, pl. lvi, fig. 4, 1851.

"*Spec. Char.* Semicircular, gibbous; surface smooth; cardinal area wide, concave, triangular; cardinal angles acute; mesial ridge very prominent, angular, both it and the angular mesial furrow without ribs; eight or nine strong rounded equal ribs on each side of the mesial fold.

"This species is allied to *Spirifer distans*, Sow., and *Sp. ostiolata*, Phillips, but is distinguished from both by the very prominent, angular mesial fold; *Sp. distans* has also the mesial hollow ribbed, while it is smooth in the present species.

"Length 1 inch, width 1 inch 5 lines."

*Obs.* Professor M'Coy's figure represents a shell having about twenty-two ribs on each valve and a smooth mesial fold, while Professor De Koninck's illustration of what he considers to belong to the same species from Belgium would only possess about fourteen, these being likewise much wider proportionately to the mesial fold than those of Professor M'Coy's example. I cannot, therefore, positively affirm that both did belong to the same species, although such in reality may have been the case.

*Loc.* Mr. Kelly mentions Millecent and Hook as the Irish localities. M. De Koninck found it at Chokier, in Belgium, where it is stated to be very rare.

SPIRIFERA SUBCONICA, *Martin*. Plate IX, fig. 3.

CONCHYLIOLITHUS SUBCONICUS, *Martin*. Petrefacta Derbiensia, tab. xlvii, figs. 6—8, 1809.

*Spec. Char.* Wider than long; dorsal valve semicircular; ventral, sub-pyramidal; hinge-line straight, as long as the greatest width of the shell; area large, triangular; fissure of moderate width. The smaller valve possesses an angular mesial fold, with corresponding sinus in the opposite one. Both valves are ornamented by about sixteen angular ribs.

Length 14, width 18, depth 11 lines.

[1] Not having had the opportunity of examining any example of this species, and as the original is no longer to be found in Dr. Griffith's collection, all that can be done is to reproduce the author's description and figure.

## PLATE I.

### (Carboniferous Species.)

Fig.

1. Terebratula hastata, *Sowerby*. From the original example figured in the 'Mineral Conchology.' *Loc.* Limerick. Collection of J. de C. Sowerby.
2. — — The largest specimen I have seen from Millecent. Collection of Mr. Griffith.
3. — — A very elongated example from Derbyshire, also figured by Professor Phillips. British Museum.
4. — — Ventral valve. *Loc.* Kildare.
5. — — From Settle, Yorkshire. Collection of Mr. Reed.
6. — — A beautiful example from Park Hill, Longnor, Derbyshire, in which bands or stripes due to colour are still preserved. Museum of the Geological Survey.
7. — — A short, very pentagonal form. In the collection of the late Mr. Daniel Sharpe.
8. — — A young ovate example from Longnor, Derbyshire. Museum of Practical Geology.
9. — — A young specimen (enlarged), showing remains of colour; kindly presented to me by Mr. E. Wood, of Richmond.
10. — — Interior of the dorsal valve, showing that the loop was short.
11. — — A short and unusual shape from the Valley of the Maine, County Kerry. Museum of the Geological Society.
12. — — *T. virgoides*, M'Coy. From pl. iii D, fig. 23, of M'Coy's 'British Palæozoic Fossils.'
13. — — var. *ficus*, M'Coy? A very elongated variety, convex, and without mesial depression on either valve. From Park Hill, Longnor, Derbyshire. Museum of Practical Geology.
14. — — Another similar example in the collection of Professor Phillips.
15. — — *T. ficus*, M'Coy. From pl. iii D, fig. 22, of the 'British Palæozoic Fossils.' Derbyshire.
16. — — With remains of colour; from Park Hill, Longnor. Museum of Practical Geology.
17. — ? Derbyshire. Cambridge Museum.
18, 19, 20. — Gillingensis, *Dav.* From Gilling, in Yorkshire. Collection of Mr. E. Wood, of Richmond.
21, 22. ? — subtilita, *Hall.* From Mayen Wais. Collection of Professor Phillips.
23. — sacculus, *Martin.* Pet. Derb. pl. lxiv, figs. 1, 2.
24. — — A large example from Bolland. Collection of Mr. Read.
25, 26, 28, 31, 32. Terebratula vesicularis, *De Koninck.* Yorkshire. Collection of Mr. E. Wood.
27, 29, 30. — sacculus, *Martin.* Park Hill, Longnor, Derbyshire.

Th Davidson, del et lith

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## PLATE II.

(Carboniferous Species.)

Fig.

1—8. Terebratula vesicularis, *De Koninck.* Different varieties of shape. Figs. 1, 2, 3, 4, 6 from the Yoredale Rocks, Wensleydale, Yorkshire, and collection of Mr. E. Wood. Figs. 5, 8 from Pilsbury Castle, Longnor, Derbyshire. Museum of the Geological Survey. Fig. 7 enlarged from a specimen in the Cambridge Museum, erroneously identified with *Ter. seminula* of Phillips by Professor M'Coy.

9, 10, 11. Spirifera duplicicosta, *Phillips.* Young individuals? according to Professor Phillips and De Koninck, from Thorpe, Cloud Hill, Dovedale, and Park Hill, Longnor; but these very transverse specimens lead me to doubt the identification, and perhaps they should be considered the young of *Sp. striata.*

12, 13. — striata, *Martin,* var. *attenuata,* Sowerby. These two examples are drawn from the original specimens figured in the 'Mineral Conchology' as *Sp. attenuata.* Kildare, Ireland.

14. — — Millecent. Collection of the late Mr. Daniel Sharpe.

15, 16. — — Var. with very small ribs. From Dovedale, Derbyshire. Museum of Practical Geology.

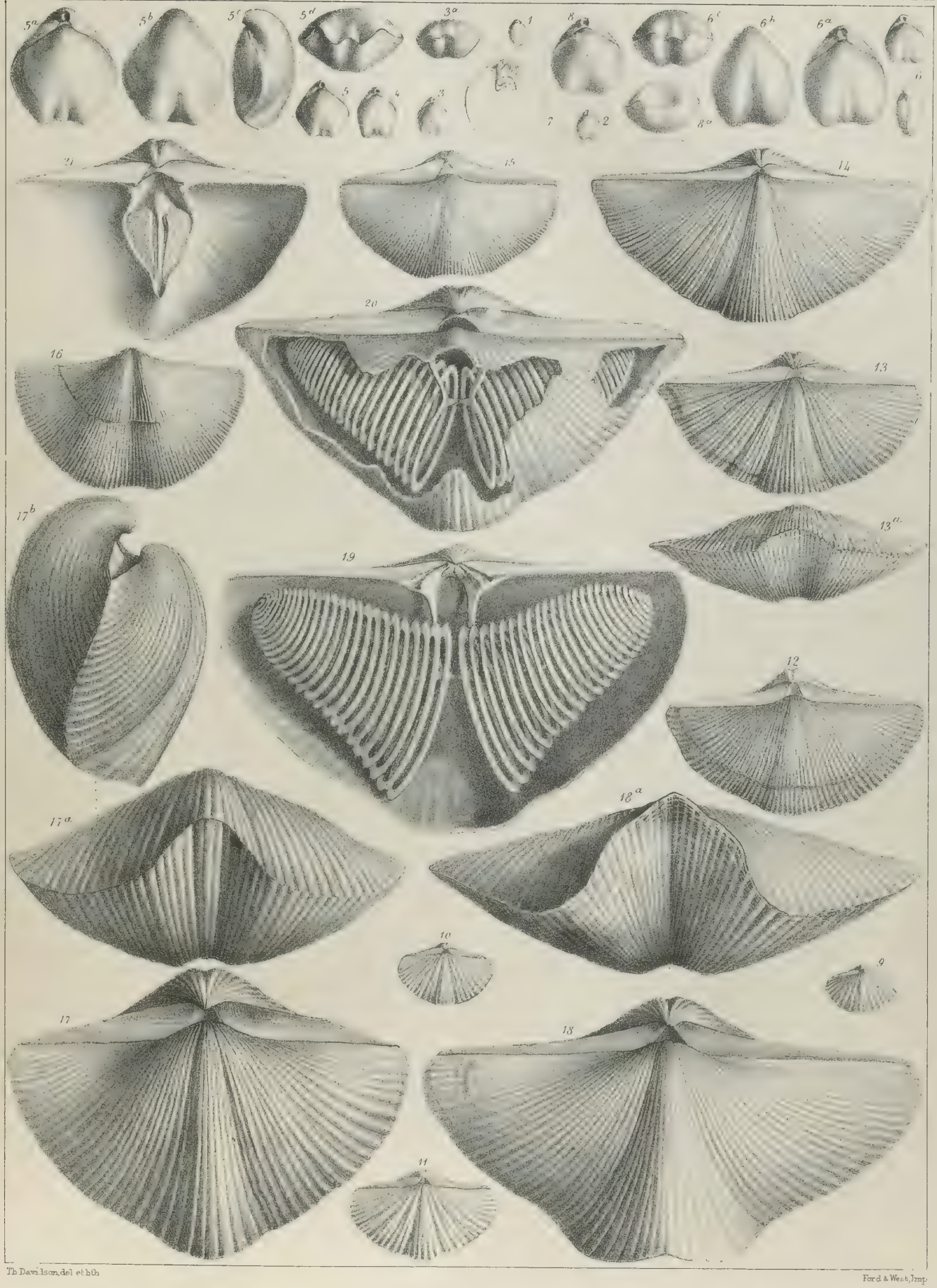
17. — — From the Craven district, Yorkshire, and collection of Mr. E. Wood.

18. — — A remarkable variety, with very deep sinus, and produced mesial fold. Bolland, in the collection of Mr. J. de C. Sowerby. Another similar example may be seen in the British Museum.

19. — — Interior of the dorsal valve, with perfect spiral appendages.

20. — — This illustration is taken from a beautifully perfect specimen in the Cambridge Museum, in which the matrix enveloping the spirals had been carefully removed by the means of acid; the shell and its spiral lamellæ being silicified. The spirals are here represented, as seen by removing a portion of the dorsal valve; so that the back and front view of these appendages are completely illustrated in figs. 19 and 20.

21. — — Interior of the ventral valve, to show the muscular impressions, &c. From a specimen in the British Museum.

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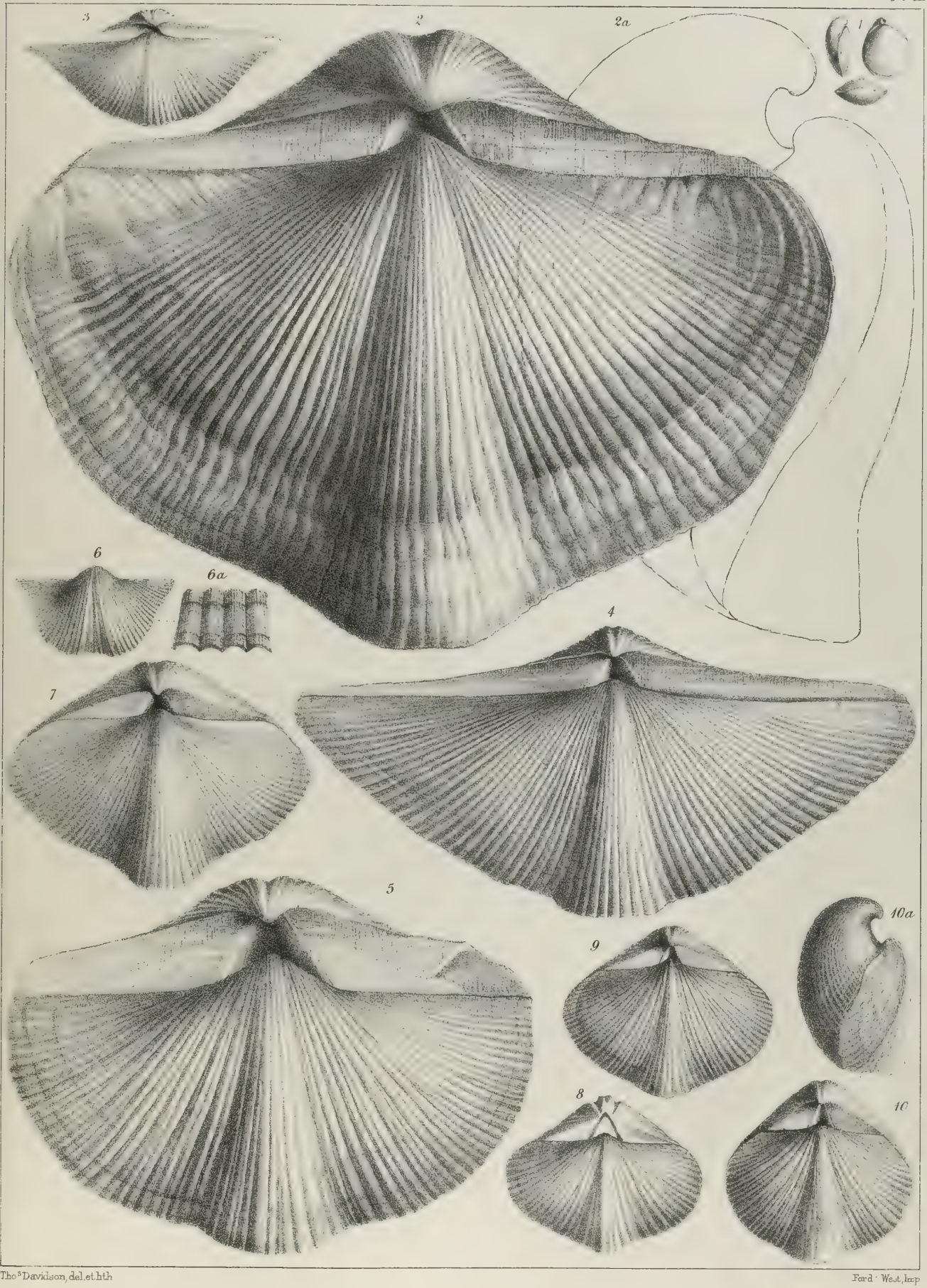
## PLATE III.

(Carboniferous Species.)

Fig.

1. Terebratula Gillingensis, *Dav.* From Westlothian. Collection of Dr. Fleming.
2. Spirifera striata, *Bolland.* Gilbertson's collection in British Museum. This is the largest example of the species at present known in England, and is the *Sp. princeps* of M'Coy.
3. — — var. *attenuata.* From Millecent.
4. — — From a specimen in grit, near Richmond, Yorkshire. Collection of Mr. E. Wood.
5. — — From Ireland, Museum of Practical Geology. Mr. Kelly informs me that similar specimens are not uncommon at Cornacarron, near Inniskillen.
6. — — This figure is taken from the 'Synopsis of Carb. Fossils of Ireland,' pl. xix, fig. 9, and represents M'Coy's *Sp. clatharata.*
7. — duplicicosta, *Phillips.* From the Wensleydale district, Yorkshire, and collection of Mr. E. Wood.
8. — — This figure is taken from Phillips's 'Geology of Yorkshire,' vol. ii, pl. x, fig. 1, and is the author's type.
9, 10. — — Two typical shapes; fig. 9 from Park Hill, Longnor, Derbyshire; fig. 10 from Poolvash, Isle of Man: Museum of Practical Geology.

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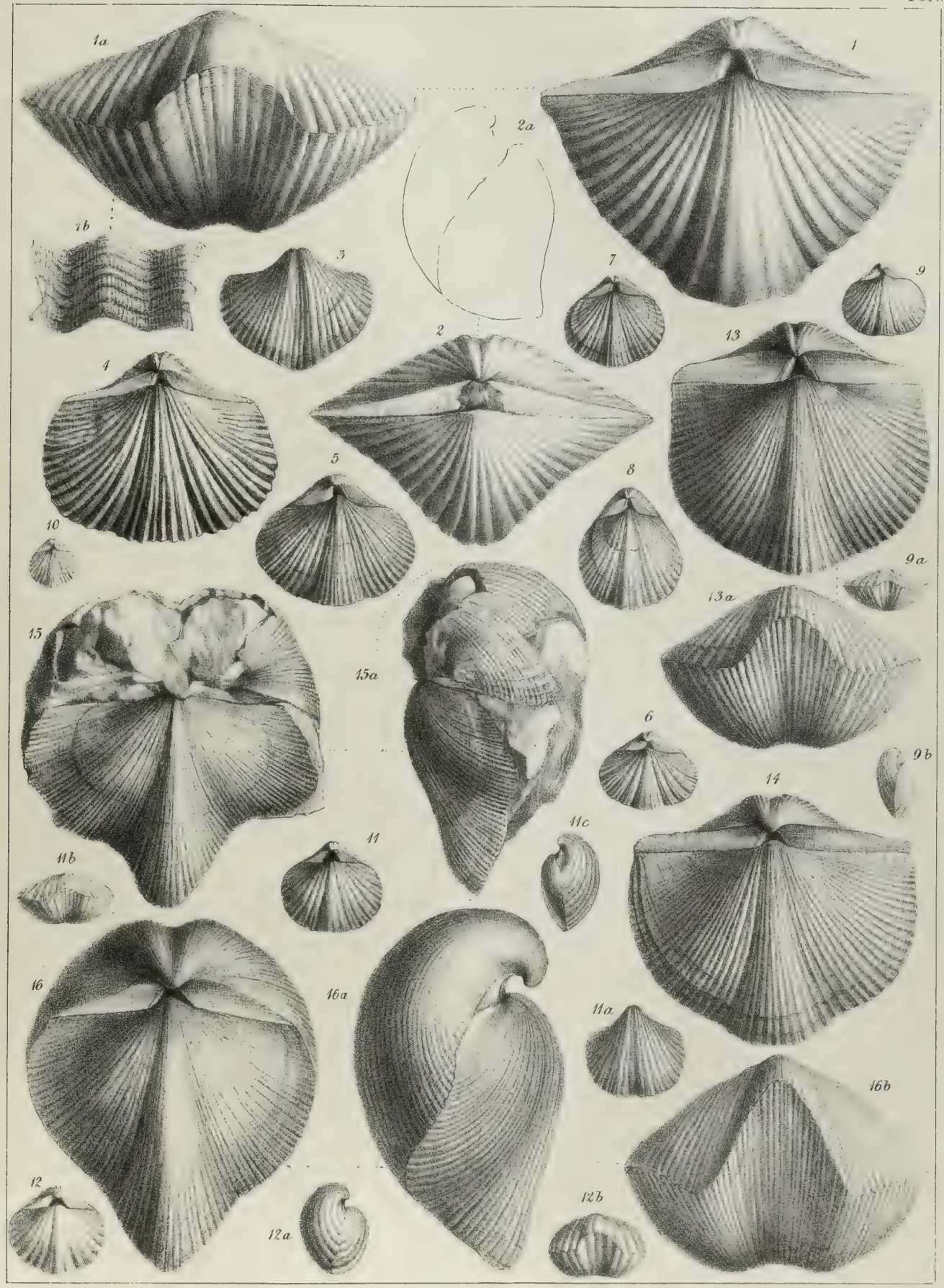
## PLATE IV.

(Carboniferous Species.)

Fig.

1. Spirifera bisulcata, var., *Sowerby*. Bolland. Collection of M. De Koninck.
2. — transiens, *M'Coy*. Taken from the 'Synopsis of Carboniferous Fossils of Ireland,' tab. xix, fig. 14.
3. — duplicicosta, *Phillips*. This figure is taken from the 'Synopsis of Carboniferous Fossils of Ireland,' pl. xxii, fig. 12, where it is described under the name of *Sp. furcata*, M'Coy, but is evidently the same as *duplicicosta*.
4. — — A var. with wide ribs, from Park Hill, Longnor; in the Museum of Practical Geology.
5—11. — — Varieties of age, as admitted by Professor Phillips and M. De Koninck. Fig. 5 is from Bolland, collection of Professor Phillips; 6, 7, 9, 10 from Park Hill, Longnor, Derbyshire, Museum of Practical Geology; fig. 8, a very elongated shape from Bolland; fig. 11 is what Professor M'Coy has described and illustrated as *Sp. fasciculata* in tab. iii D, fig. 25, of the 'British Palæozoic Fossils.'
12. — penguis, *Sowerby?* *Sp. paucicostata*, M'Coy. These figures are taken from the 'British Palæozoic Fossils,' pl. iii D, fig. 26. Derbyshire; in the Museum of Cambridge. It is probably a young shell of Sowerby's species.
13. — mosquensis, *Fischer*. Derbyshire. Cambridge Museum.
14. — — From Little Ireland (Ireland). Collection of the Royal Dublin Society. (See also pl. ix, fig. 4.)
15. — humerosa, *Phillips*. This illustration is drawn from the original specimen on which Professor Phillips founded his species. 'Geology of Yorkshire,' vol. ii, pl. xi, fig. 8; and is from Greenhow Hill. Collection of Professor Phillips.
16. — — A perfect example, in the collection of Mr. E. Wood, from the Wensleydale district, Yorkshire. (See also pl. ix, fig. 5.)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# PLATE. V.

(Carboniferous Species.)

1. Spirifera bisulcata, *Sowerby*. Yorkshire. Collection of Mr. Reed.
2, 3. — convoluta, var. *rhomboidea*, Phillips. Drawn from the original specimen figured in the 'Geology of Yorkshire,' vol. ii, tab. ix, figs. 8 and 9.
4—6. — — From Lancashire. Collection of Mr. Parker, of Manchester.
7, 8. — — From Bolland. Collection of Professor Phillips.
9—11. — — *Phillips*. From the original example; 'Geology of Yorkshire,' vol. ii, pl. ix, fig. 7. Bolland. British Museum.
12, 13. — — From Clitheroe quarry, Lancashire. Collection of Mr. Parker, of Manchester.
14, 15. — — From Kildare. Museum of the Royal Dublin Society.
16, 17. Spirifera triangularis, *Martin*. The original example figured in the 'Pet. Derb.,' pl. xxxvi, fig. 2; also 'Min. Con.,' tab. 562, figs. 5 and 6. From Derbyshire. Collection of Mr. J. de C. Sowerby.
18—21. — — A perfect individual. From Yorkshire. Collection of Mr. Reed, of York.
22. — — An imperfect example. From the Wensleydale district, Yorkshire.
23. Spirifera triangularis = sp. *ornithorhyncha*, M'Coy. This is one of the original examples upon which Professor M'Coy founded his species. *Loc.* Millecent (Clare). Collection of Mr. Griffith.
24. — — From Bolland; in the collection of Mr. Reed.
25. — trigonalis, *Martin*. After the original figure, 'Pet. Derb.,' tab. xxxvi, fig. 1. Derbyshire.
26. — — Cast of the interior of the dorsal valve, with beak of the ventral one; from Bakewell, Derbyshire, presented to me by Mr. Binny. a. Adductor impressions.
27. — — Cast of the interior of the ventral valve. a. Adductor. r. Cardinal muscular impressions. o. Ovarian spaces.
28. — — From Buxton.
29—32. — From a beautiful example in the collection of Mr. Tate. Denwick, Northumberland.
33. — — From Courland, near Dalkeith.
34. — — Interior, showing the spirals; from the original example figured in the 'Min. Con.,' tab. 265, fig. 1, under the erroneous denomination of *Sp. bisulcatus*. Derbyshire.
35—37. ? A remarkable and unusual form; from Campsie, near Glasgow; in the collection of Mr. A. Cowan.
38, 39. Spirifera grandicostata, *M'Coy*. After the author's illustrations in the 'British Palæozoic Fossils, pl. iiid, fig. 29.
40—42. Spirifera Reedii, *Davidson*. British Museum.
43—48. — — Two young examples; from Settle, Yorkshire. Collection of Mr. Reed.

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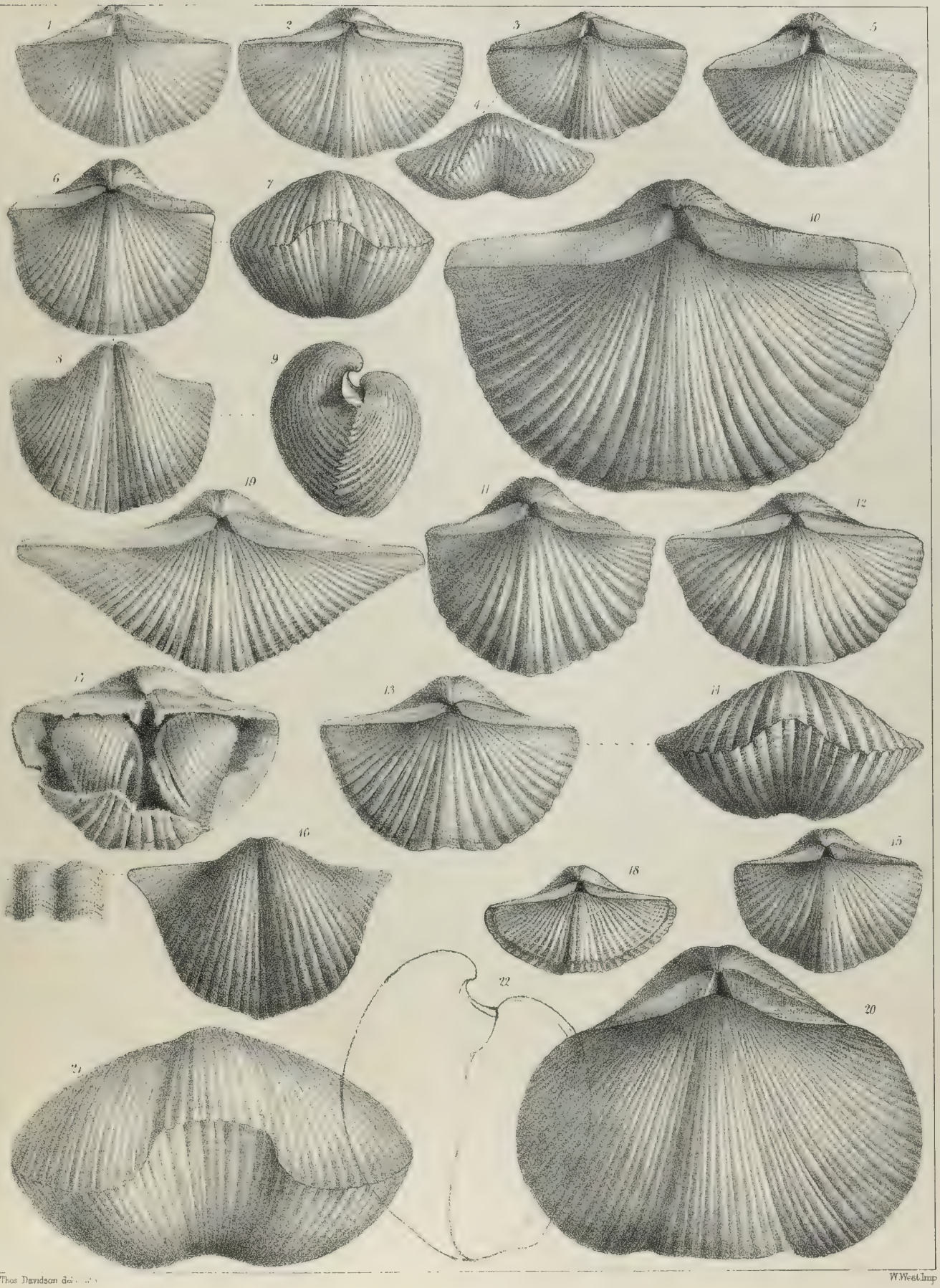
## PLATE VI.

(Carboniferous Species.)

Fig.

1. Spirifera bisulcata, *Sowerby*, var. *semicircularis*, Phillips. From the original illustration, 'Geol. of Yorkshire,' vol. ii, tab. ix, fig. 15. Bolland.
2. — — var. *semicircularis*. Bolland. Collection of Mr. Muschen.
3—4. — — In the collection of Professor Phillips, labelled *Sp. semicircularis*. Bolland.
5. — — From Twiston, Lancashire. Collection of Mr. Parker.
6—9. — — From the original type specimen, 'Min. Con.,' tab. 494, fig. 1. Collection of Mr. J. de C. Sowerby.
10. — — A very large example from Dovedale, Derbyshire; in the Museum of Practical Geology.
11. — — A specimen with very large ribs, from the Wensleydale district, Yorkshire. Collection of Mr. E. Wood.
12. — — From Derbyshire; several of the ribs are bifurcated.
13, 14. — — From the specimen, 'Min. Con.,' tab. 265, fig. 3, erroneously described by Sowerby as *Sp. trigonalis*.
15. — — From Craigenglen (Campsie), Scotland. Collection of Mr. Young.
16. — — Ventral valve, from Barrhead, Scotland. Collection of Mr. A. Cowan. The fine imbricated lines which cover the costæ are beautifully seen in this example.
17. — — From a specimen in the collection of Mr. J. de C. Sowerby. Derbyshire.
18. — — A very transverse young specimen, from the Wensleydale district, Yorkshire. Collection of Mr. E. Wood, of Richmond.
19. — — A very transverse specimen, in the collection of Dr. Reed, of York. Yorkshire.

20—22. Spirifera crassa, *De Koninck* = *Brachythyris planicosta*, M'Coy. This is the original specimen, imperfectly illustrated in the 'Synopsis of the Carboniferous Fossils of Ireland,' tab. xxi, fig. 5. *Loc.* Mullaghfin, Duluk, Ireland.




Thos Davidson del. et lith.
W.West.Imp

# PLATE VII.

(Carboniferous Species.)

Fig.

1, 2. Spirifera crassa? *De Koninck.* Millecent, Ireland.

3. — — In this specimen no mesial fold is observable. From the lower limestone of Milverton, Skerrie, Ireland. Collection of Mr. Griffith.

4. — bisulcata. A malformation. This illustration is taken from the specimen named *Sp. calcarata* by M'Coy. 'Synopsis of the Carboniferous Fossils of Ireland,' pl. xxi, fig. 3.

5, 6. Spirifera acuta, *Martin.* From the 'Pet. Derb.,' tab. xlix, figs. 15, 16. *Loc.* Winster, Derbyshire.

7. Spirifera grandicostata, *M'Coy.* Bolland. British Museum.

8—11. — — A beautiful example from Bolland. Collection of Mr. Muschen.

12. — — Front view of a specimen from Park Hill, Longnor, Derbyshire. Museum of Practical Geology.

13. — — A very large ribbed specimen, from Bolland. Collection of Mr. E. Wood.

14, 15, 16. — A young shell, from Park Hill, Longnor. Museum of Practical Geology. Young shells. 15. Collection of Mr. E. Wood.

17. Spirifera laminosa, *M'Coy.* Drawn from two examples in the collection of Mr. Griffith. Hook, Ireland.

18, 19. — — From Hook. Museum of the Geological Survey of Ireland.

20. — — A young shell from Hook.

21, 22. — — A var. from Derbyshire. Cambridge Museum.

23. Spirifera decemcostata, *M'Coy.* From the original specimen. 'Synopsis of the Carboniferous Fossils of Ireland,' pl. xxii, fig. 9. Millecent; Kildare. Collection of Mr. Griffith.

24. — mesogonia, *M'Coy.* 'Synopsis of the Carboniferous Fossils of Ireland,' tab. xxii, fig. 13. Ireland.

25—28. Spirifera planata, *Phillips.* Bolland. Collection of Mr. Muschen.

29. — — Professor Phillips's type. British Museum. Bolland.

30—32. — — Collection of Professor Phillips. Bolland.

33, 34. — — A circular specimen in the collection of Mr. Muschen.

35. — — Collection of Professor Phillips. Bolland.

36. — — Young shell in the collection of Mr. Muschen.

37—41. Spiriferina cristata, var. *octoplicata,* Sowerby. From the original examples. 'Min. Con.,' tab. 562, figs. 2 and 3. Derbyshire, and collection of Mr. J. de C. Sowerby.

42—44. — — From the shores of Lough Hill, County Sligo. Collection of the Geological Society. Fig. 44 enlarged, to show the cardinal area, cardinal process, and central septum of the ventral valve.

45—46. — — From Westlothian, Scotland. Collection of Dr. Fleming.

47. — — From the shores of Lough Hill, County of Sligo. Collection of the Geological Society.

48, 49, 50. — insculpta, *Phillips.* Young shells from Longnor, Derbyshire. Museum of Practical Geology.

51. — — From the specimen named *Sp. quinquelobas,* M'Coy. 'Synopsis,' tab. xxii, fig. 7. From Ardagh, Drumcondra, Ireland. Collection of Mr. Griffith.

52—55. — — Adult. Yorkshire. Museum of Practical Geology.

56—59. — minima, *Sowerby.* From the two figured types. 'Min. Con.,' tab. 377. Bakewell. Collection of Mr. J. de C. Sowerby.

60—61. — partita, *Portlock.* Copies from the 'Rep. of the Geol. of Londonderry, &c.,' tab. xxxviii, fig. 3. Ireland.

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## PLATE VIII.

(Carboniferous Species.)

Fig.

1—4. Spirifera distans, *Sowerby*. From the original example, 'Min. Con.,' tab. 494, fig. 3. Ireland. Collection of Mr. J. de C. Sowerby.

5—8. — — Ireland.

9, 10. — — In the collection of Professor Tennant. Ireland.

11—14. — — In the collection of Professor L. de Koninck. Millecent, Ireland.

15. — — Ireland. Figs. 1 to 17 exemplify the different states of development and incurvation of the beak and area, &c.

16. — — A very wide example. Millecent.

17. — — This figure shows the development attained by the dental or rostral plates (s) in the ventral valve.

18. — bicarinata, *M'Coy*. 'Synopsis of the Carboniferous Limestone Fossils of Ireland,' pl. xxii, fig. 10.

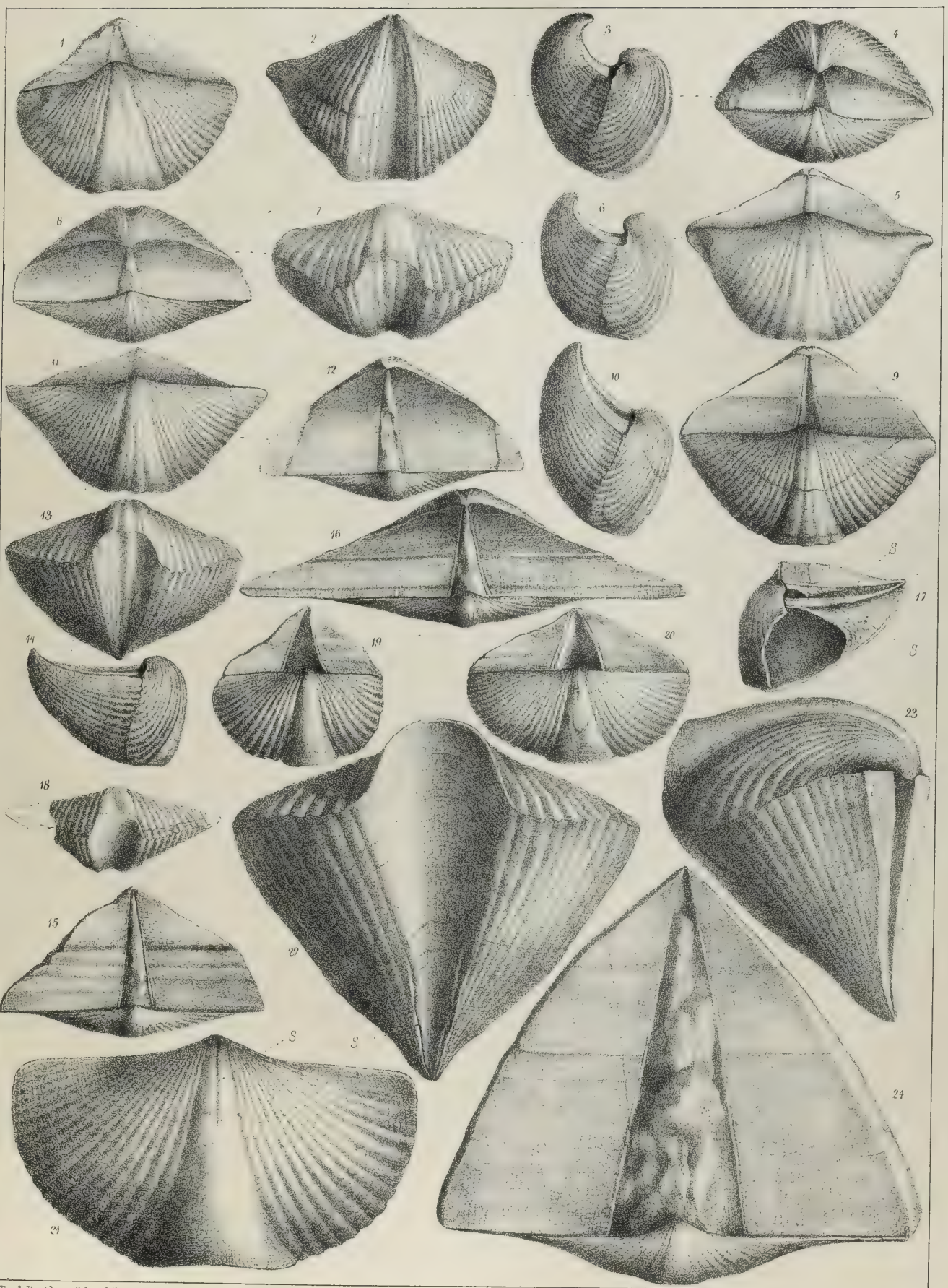
19. — cuspidata, *Martin*.[1] From Millecent. Small specimen.

20. — — From a gritty sandstone near Kendal.

21—23. — — A large example from Ireland. In the collection of Mr. Reed, of York.

24. — — A very large specimen from the Black Rock, Cork, Ireland.

[1] At p. 45, I stated that no specimen of *Sp. cuspidata* I had hitherto been able to examine possessed its deltidium, and that I considered it was in all probability not perforated by a circular foramen, as in true types of the sub-genus *Cyrtia*. Subsequently, however, Mr. J. P. Woodward showed me the internal cast of the ventral valve of a specimen in the British Museum, thought to have belonged to *Sp. cuspidata*, and derived from the dolomitic Carboniferous limestone of Breedon hill (pl. ix, figs. 1 and 1 *a*) in which there is evidence that the deltidium was in reality perforated by a circular foramen, as in *Cyrtia*.

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W West Imp

THE

# PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCLVII.

MONOGRAPH

ON

# THE FOSSIL REPTILIA

OF THE

# WEALDEN FORMATION.

BY

PROFESSOR OWEN, F.R.S., F.L.S., F.G.S., &c.

PART IV.

LONDON:

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PRINTED BY J. E. ADLARD, BARTHOLOMEW CLOSE.

# MONOGRAPH

ON

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OF

# THE WEALDEN FORMATIONS.

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## IGUANODON.

### Supplement No. 1.

*Restoration of the (Hind?) Foot.*

In the 'Monograph on the Iguanodon,' in a former volume of the publications of the Palæontographical Society,* the characteristic form of certain toe-phalanges was described; such phalanges, at least, were inferred to belong to the Iguanodon, with a high degree of probability, on evidence of association with other undoubted parts of the skeleton of that reptile, and more especially in the instance of the Maidstone skeleton;† but at that period the exact structure and number of toes of either fore or hind foot were unknown.

On the basis, however, of the determination of detached phalangeal bones in that monograph, the present restoration of an entire—probably hind—foot, the carpus or tarsus excepted, of the Iguanodon, has been carried out; the ungual phalanges in the series of bones of this foot (T. I, II, III) closely corresponding in shape with the depressed and obtuse phalanges referred to that extinct animal in the above-cited volume, 1855, pp. 42—44. This most interesting and instructive framework of the foot of the great Dinosaurian herbivorous reptile was, moreover, found in a formation and at a locality where unequivocal vertebræ and other parts of the Iguanodon are common;

* Volume for 1855, p. 40, t. xvi and xvii.

† Volume for 1851, p. 105, t. xxxiii.

so that it is with much confidence that the present contribution towards a complete reconstruction of the Iguanodon is now submitted to palæontologists.

The discovery and acquisition of the unique specimen, figured in T. I, II, and III, are due to S. H. Beckles, Esq., F.G.S., the author of the papers on the 'Ornithöidichnites of the Wealden,'* and who first definitely called the attention of geologists to the singular "trifid," or tridactyle impressions in the Wealden of Sussex, of which he was the chief discoverer, and has been the most persevering investigator.

It seems a peculiarly appropriate reward for these researches, that the acquisition of the fossils demonstrating the tridactyle structure of one of the feet of the Iguanodon should have been reserved for Mr. Beckles. These fossils, moreover, were not fortuitously acquired, but were the fruit of special researches, assiduously carried on by Mr. Beckles on the south-west coast of the Isle of Wight, with a view to materials for completing our knowledge of the great Wealden reptiles.

Between Brook and Brixton, in the submerged Wealden bed, near low-water mark, indications of the entire skeleton of a young, perhaps half-grown, Iguanodon were detected. The bones of the foot which were most within reach had been very little disturbed. The metatarsus (T. II, fig. 2) was extracted in one piece; the phalanges of an outer toe (T. I, 1 IV—5 IV) were extracted in a second piece: they had been somewhat distorted at the time of imbedding, for the matrix had hardened around, and preserved them in that state. The phalanges of the toe of the opposite side of the foot (ib., 1 II—3 II) were extracted similarly cemented together by the matrix, but in their natural juxtaposition. Three of the phalanges of the middle toe (ib., 1 III—3 III) were also joined together by the matrix; the fourth, or ungual phalanx of this toe, was extracted separately; but Mr. Beckles's attention having been, unluckily, diverted to another subject at this time, the fossil got into the hands of an idle looker-on, who cast it into the sea. All the other bones of the foot Mr. Beckles caused to be carefully packed, and transmitted to me for description.

I employed a skilful lapidary to clear away the adherent matrix, and to separate the cemented phalanges of the distorted toe, for the examination of their articular surfaces, and the result of my comparisons were communicated briefly to the Geological Society of London, on the occasion of exhibiting the specimen at the meeting held June 17th, 1857.

As has already been stated, the bones, whether carpal or tarsal, which unite the foot proper to the limb, are wanting. The metapodium,† fortunately, yields the required proof of the precise number of toes.

* 'Quarterly Journal of the Geological Society,' January, 1851, and November, 1852.

† I use this word to signify the same segment in both fore- and hind-limbs: "metacarpus" is the specific term for the segment in the fore-limb; "metatarsus" for that in the hind-limb. But, in the gradual reconstruction of the skeleton of a strange reptile, it is requisite to have a term expressive of the more general kind of knowledge at first acquired. Metapodial is equivalent to metacarpal or metatarsal.

As a general rule, only the metapodials which bound or form the outer and the inner sides of that segment of the foot have the proximo-lateral articular surface confined to one side of the bone; the intermediate metapodials show such surface on both sides, for articulation with the contiguous metapodials. The metapodial (T. I, II, and III, IV), which will presently be shown to be the outermost, had its outer side rounded, and simply roughened for the implantation of ligamentous fibres; the metapodial on the opposite side (ib., II) also presented a convexity toward that border of the foot; but a small part of the middle of that convexity is articulated with a slender rudiment of a metapodial (ib., I), which forms the real boundary of that—the inner side of the foot. The upper portion of this metapodial, which resembles the "splint-bone" in the metapodium of the horse, has been fractured and partially dislocated before the induration of the matrix; the lower portion of the bone is in its natural position, and seems to have been anchylosed with the contiguous fully developed metapodium: the extremity of this lower portion, however, is broken away; so that, whether it ended in a point, like the rudimental metapodials in the horse, or supported a diminutive toe, like the metapodials of the spurious hoofs in the ox and musk-deer, cannot be at present determined.

As the fully developed toes which follow this rudiment have respectively three, four, and five phalanges, the analogy of both the fore- and hind-foot of the Iguanas and Monitors would indicate the small innermost metapodial (T. I, II, and III, I) to be the rudiment of the first toe (pollex or hallux), and the three fully developed toes to be the homologues of the second, third, and fourth toes of the feet in the Lizard tribe; the fifth toe being wholly suppressed in the Iguanodon. The analogy of the Crocodilian foot would lead to the same conclusion, since the second toe in that reptile has three phalanges, and the third toe has four phalanges, whilst in the hind-foot the fifth toe is suppressed. The fourth toe, however, in the *Crocodilia* differs from that in the *Lacertilia*, in having only four phalanges, and usually wanting a claw. Hence it would seem that, whilst the Iguanodon resembled the *Crocodilia*, as regards the hind-foot in that order, in the suppression of the fifth toe, it resembled the *Lacertilia* in having the fourth toe unguiculate, and with five phalanges: but it differs from both those Reptilian orders in the suppression of the first toe, and its representation by a hidden rudimental metatarsal, thus reducing the number of conspicuous and functional toes to "three."

The resemblance to the hind-foot of the *Crocodilia* in the suppression of the fifth toe, and the resemblance of the third and fourth toes, in regard to their nearly equal length, to those toes in the Monitor, render it most probable that the tridactyle foot of the Iguanodon, here described, is a "hind-foot;" but it cannot be assumed that the fore-foot may not have been similarly modified.

In the leading characteristics of the bony framework of the foot, whether fore or hind, it is interesting to find that the Iguanodon manifests a combination of Croco-

dilian and Lacertian characters, with superinduced Dinosaurian peculiarities, analogous to the plan of structure which I have had occasion to point out in other parts of its fossilized remains. So far as the Dinosaurian peculiarity of a reduced number of functional toes prevails, that order departs further from the general Reptilian type than do the existing Crocodiles and Lizards.

Having premised these general remarks on the fossils in question, I proceed next to point out the chief characters of the constituent bones of the foot.

The rudimental metapodial of the first or innermost toe (T. I, II, III, 1) articulates by its proximal end with a notch, 9 lines in diameter, at the middle of the inner (tibial) surface of the second metapodial (11). It seems not to have been anchylosed at this part, from the circumstance that the slender bone has been broken, soon after death or interment, and the upper portion has been displaced obliquely from the lower half, which maintains, perhaps through anchylosis, its natural position; the displaced portion is cemented in that position by the hardened matrix to the contiguous large metapodial.* The rudimental metapodial, 9 lines by 6 lines in the two diameters of its proximal end, gradually becomes more slender as it descends; its lower half is trihedral, and stands rather sharply out from the large metapodial (11); its extremity is broken off; the large and small diameters of the lower fractured end are 5 lines and 3 lines. It is not probable that its presence was conspicuous beneath the integument which covered it, but it may have supported a rudimental toe and claw.

The second metapodial (ib., 11) is 8 inches in length, $4\frac{1}{2}$ inches in the longest diameter of the proximal end, 3 inches in that of the distal end. The bone expands at both ends, more suddenly at the distal one; it is convex on its free or tibial side, flattened on the side next the third metapodial, with the anterior border produced near the middle of the shaft into a process with a convex outline, and with a ridge projecting from the inner and back part of the proximal end. This ridge has been fractured. The outer or fibular angle of the back part of the proximal end is produced towards the next large metapodial, but has likewise been fractured. The articular surface at this end is flat, rather rough, showing vascular pits and other evidence of having been covered, in the recent state, by a layer of fibro-cartilage: by which it was articulated to the innermost tarsal or carpal bone. The distal articular surface is convex from before backwards, slightly convex transversely at its anterior half, with a middle concavity and lateral convexities, transversely, at the posterior half, which is somewhat broader than the fore part of the joint, and with the outer (fibular) angle produced.

The inner (tibial) side of the distal end of this metapodial has a broad and shallow depression for the attachment of a lateral ligament; the articular surface is two inches

* In the figure it is represented as restored to its natural position.

and a half higher than that of the adjoining (third) metapodial, and the proximal end is one inch and a half higher than that of the adjoining bone; but this is probably due to some dislocation of the metapodial before the matrix hardened around it.

The third metapodial (ib., III) is $11\frac{1}{2}$ inches in length. The proximal articular surface is slightly convex; a small portion of its back part (T. II, *a*) is continued upon the thick process (*b*) from the back part of the bone, which rises some way above the level of the horizontal surface, apparently about an inch; but the summit of this process has been broken off. This process subsides as it descends to the inner border of the shaft, about halfway down.

The inner and anterior angle of the proximal end is produced toward the second metapodial, rendering the side next that bone rather hollowed out, as for its reception when in its proper position. There is no process from the middle of the shaft near its fore part, as in the second metapodial. The distal end (T. II, fig. 3, III) expands into a broad trochlear surface, convex from before backwards, concave transversely; the fore-and-aft extent of the tibial side of this joint is the greatest; it appears to have been covered by articular cartilage, the extent of the cartilage being well defined by the transverse line at which the smooth surface rises a little above the level of the rough surface for ligamentous attachment.

The fourth metapodial (T. I, II, III, IV), which is here the third fully developed, and at the same time the outermost one, is 9 inches in length. Its proximal end (T. II, fig. 1, IV) is of a semi-elliptical form, concave towards the middle metatarsal, to which it articulates in the present specimen two inches below the proximal end of that bone; but there may have been some displacement of the bone prior to fossilization. The inner and posterior angle of the upper part of the shaft of the fourth metatarsal is slightly produced, as is also the same angle of the shaft below its middle. The front surface of the shaft is smooth and convex; the back part is almost flat, and is crossed obliquely near its lower end by a rough ridge.

The distal articular surface (ib., fig. 3, IV) is oblique, but in the opposite direction to that of the second metapodial (II); the transverse concavity of the surface is slight, and is also limited to the hinder half; the anterior fibular angle is produced. The extent of the articular cartilage of the joint is indicated by the raised line, as in the middle metapodial; the concavity on the inner side of the distal end is deep and well defined.

The innermost of the three toes (T. I and III, II 1, 2, 3), answering to the second in the hind-foot of the Iguana, includes three phalanges, and measures in total length 10 inches.

The first phalanx (II 1) is $4\frac{1}{2}$ inches in length; its proximal surface is obliquely sub-quadrate, very slightly concave, with the upper and outer (fibular) angle most produced, but rounded off; it is notched at the middle of the lower (plantar) border. Near this border, on the plantar aspect of the shaft, are two tuberosities for insertion of tendons. The distal articular surface is a trochlear one, convex vertically, and

expanding as it descends; concave, but in a less degree, transversely; with the inner (tibial) side of greater extent. On both sides the articular border is slightly raised, forming the lower boundary of the wide concavity for the attachment of the lateral ligaments.

The second phalanx (II 2) is broader than it is long, its extreme breadth being 2 inches 4 lines. The proximal articular surface, with its concavity and convexity the reverse of those of the surface on which it plays, is triangular, with the angles largely rounded off. The under surface of this phalanx is somewhat flattened; the upper surface is contracted; the distal trochlea, very convex vertically, is flat transversely, at its upper half, slightly concave below; the modification resembling that of the phalanx supporting the unequal one in the other toes.

The third phalanx (II 3), which supported the claw, presents an oblique basal articular surface, flattened transversely and produced backwards above; slightly convex transversely below. The unequal part is sub-depressed, obtuse, obliquely bent downwards and outwards, but in a slight degree: the base of the bone is notched at each side, where the vascular canals relating to the growth of the claw commence; they impress the upper and lateral parts of the bone, which is $4\frac{1}{2}$ inches in length.

The proximal phalanx of the middle toe (T. I and III, III 1), answering to the third in the Iguana, shows its increase chiefly in breadth and thickness; its length is $4\frac{1}{2}$ inches. The proximal end, of a transversely oval form, is slightly and irregularly concave; its distal end is broader but less deep than that of the outer toe, and the shape of the trochlea is more symmetrical; the outer slightly exceeds the inner side in extent. The increase in the transverse over the longitudinal and vertical diameters is more marked in the second and third phalanges (III 2 and 3) of the middle toe; the latter phalanx shows the same flatness transversely, at the upper part of its distal trochlea, as in the corresponding phalanx of the outer toe. This structure indicates the next phalanx to have been an ungual one, resembling, as Mr. Beckles informed me, in its general character, the long terminal phalanx in the adjoining toes. It is indicated in outline in T. I, 4 III.

All the five phalanges of the outer toe (IV 1, 2, 3, 4, 5) are preserved; the entire length of the toe is $8\frac{1}{2}$ inches, being rather shorter than the inner, but apparently longer from the lower position of the metapodial bone (IV). In this proportion the Iguanodon differed from existing Lizards, and resembled the Crocodiles.

The proximal phalanx of the outer toe (IV 1), answering to the fourth in the Iguana's foot, is 3 inches in length, with a subtrihedral body, one side turned to the next toe, and one angle inwards and downwards. The proximal surface is flat; the distal one trochlear, but with the transverse concavity less deep than in the first phalanx of the inner toe. The three succeeding phalanges (IV 2, 3, and 4) are similar in character, but progressively decrease in size; they are very short in comparison to their breadth.

The ungual phalanx (IV 5) is relatively more slender than in the inner toe: its length is 4 inches; its basal breadth 1 inch 10 lines. The obliquity of the bone is slight, and in the opposite direction to that of the inner toe.

Should any rudimental or spurious claw have been supported by the metapodial of the innermost digit (T. II, fig. 2, 1), the development of which toe is so remarkably arrested, it would probably present that form, and in regard to the fully grown Iguanodon, that size, which characterises the claw-phalanx which has been mistaken for the "horn" of the Iguanodon. It is probable that, in the fore-foot, the toe answering to the innermost in the Iguana's foot was better developed than its homotype in the hind-foot.

Not far from where the foot-bones were found, the femur, tibia, and fibula, of the same Iguanodon were extracted,—a circumstance which adds to the probability of their belonging to the same limb.

The modification of the present foot, whether of the fore- or hind-limb, of the Iguanodon is unique, according to present knowledge, in the class *Reptilia*. It exhibits an adaptation to terrestrial progression, and the support of a weighty superincumbent trunk, akin to that which we observe in the tridactyle foot of the heavy perissodactyle Pachyderms, represented at the present day by the Rhinoceros and Tapir.

# MONOGRAPH

ON

# THE FOSSIL REPTILIA

OF

# THE WEALDEN FORMATIONS.

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## Order—*DINOSAURIA.*

### *Genus*—Hylæosaurus,* *Mantell.*

The third well-marked genus of Dinosaurian Reptiles, referred to in a former Monograph,† is founded upon a large portion of the skeleton of one and the same individual (T. IV), to which the name at the head of this section has been applied by its discoverer, Dr. Mantell.

In assigning to this genus a place in the Dinosaurian order, I have been guided by the structure of the vertebral column, especially the sacrum (T. V and VI), and, in placing it after the Megalosaurus, by the following considerations. The distinct alveoli in the jaws of the Megalosaurus, and the resemblance of its teeth to those of two extinct Crocodilians, viz., the Argenton species and the Suchosaurus, seemed to claim for that great carnivorous Dinosaur a position higher, or nearer to the Crocodilian order. In the present genus, which there is good reason for believing to have resembled the Lizards more than the Crocodiles in its dental characters, an affinity to the *Crocodilia* is, however, manifested not only by the structure of the vertebræ and ribs common to it with other Dinosaurs, but likewise by the presence of dermal bones, or scutes, with which the external surface was studded.

The Hylæosaurus has not been made known like the Megalosaurus, from detached parts of the skeleton successively discovered and analogically recomposed, but was

* ὑλαῖος, *sylvestris*, belonging to a wood, σαῦρος, lizard.

† Part iii, p 1, Palæontographical Publications for 1856.

at once brought into the domain of palæontology by the discovery of the following parts of the skeleton in almost natural juxtaposition: viz., the anterior part of the trunk (T. IV), including ten of the anterior vertebræ in succession (3—10), supporting a small fragment of the base of the skull; the two coracoids (ib., 52), the coracoid extremities of both scapulæ (ib., 51), detached vertebræ, several ribs (ib., *pl*) more or less complete, and some remarkable parts of the dermal skeleton, including, apparently, enormous vertical plates or spines (ib., *d*, *d*), arranged, as is supposed, in the form of a median dorsal ridge or crest of singular dimensions.

This specimen is now in the British Museum. It was discovered in 1832, in a block of stone, measuring $4\frac{1}{2}$ feet by $2\frac{1}{2}$ feet, in the Wealden of Tilgate, Sussex.*

In the fragment of the cranium may be distinguished the pterygoid elements of the sphenoid bone, the inner margins of which touch anteriorly and then recede as they pass backwards, leaving a heart-shaped posterior nasal aperture, the apex of which is turned forwards. The breadth of this aperture is 1 inch 3 lines: its posterior position gives another character by which the present Dinosaur, and probably the larger genera of the same order, resembled the Crocodiles more than the Lizards.

The bodies of the vertebræ are shorter in proportion to their breadth than in the Megalosaurus or Iguanodon. They have not so smooth and polished a surface as in the Megalosaurus, nor are they so contracted in the middle, or so regularly rounded below from side to side; a few of the anterior vertebræ are somewhat flattened below, so as to present an obscurely quadrate figure; most of the anterior dorsals (T. VIII, figs. 10 and 11) are more compressed and keel-shaped below; the sacral (T. V) and many of the caudal vertebræ (T. X) are longitudinally sulcated at their under surface.

The structure of the atlas and axis cannot be discerned in the British Museum specimen; the second (conspicuous) cervical vertebra (T. IV, 4)† has its sides subcompressed, its under surface rather flattened anteriorly, and the slight angular ridges separating it from the concave lateral surfaces are produced anteriorly into two feebly marked tubercles. The parapophyses, or inferior transverse processes, are developed from each side of the anterior part of the body of the vertebra; they are subcircular, very slightly prominent, about 7 lines in diameter.

In the fourth (conspicuous) vertebra (T. IV, 6)† a parapophysis is, also, developed from each side of the anterior part of the body, with the costal surface directed obliquely outwards and forwards. There is a small costal surface at the side of the expanded posterior extremity of the same vertebra, against which a part of the head of a rib abuts; that and three of the succeeding ribs having their heads applied over the interspace of two contiguous vertebræ, as nearly throughout the thoracic region in Mammalia.

* 'Proceedings of the Geological Society,' December 5th, 1832, vol. i, p. 410.

† The Arabic numerals indicate the position which I believe the vertebræ to have had in the entire series forming the back-bone of the Hylæosaur.

The lateral compression of the centrum increases in the sixth (8) and seventh (9) (conspicuous) vertebræ, in which the under surface forms an obtuse ridge; in the eighth vertebra (10) this surface is broader and more rounded. In none of these vertebræ is a process developed from the under surface, as in the hinder cervical and anterior dorsal vertebræ of the Crocodiles; and in none of them is the anterior articular surface of the centrum convex, as in the Streptospondylus.

The most striking character of the vertebræ of the Hylæosaurus is the great development of the neural arch and its processes. The anterior articular processes extend (in the anterior dorsal and cervical vertebræ) over half the centrum next in front, and a broad diapophysis (upper transverse process) is developed from the side of the neurapophysis and along its anterior continuation: the diapophysis extends horizontally outwards, is notched anteriorly, and contracts to an obtuse point, against which the tubercle of the rib articulates: it is flat transversely, slightly concave lengthwise, and smooth below. The diapophyses increase in length and strength as the vertebræ extend along the trunk; and the ribs, which they contribute to support, exhibit a still more rapid increase. The ribs present, as in the other Dinosaurs and Crocodiles, a bifurcated vertebral end, for the double articulation above described (T. IV, *pl* 3, and the ribs attached to 9 and 10). The rib (*pl* 2) which appears to be the second, and belongs to the cervical region, is short and pointed, not exceeding 4 inches in length. The neck and head of the rib corresponding with the seventh conspicuous vertebra, apparently the third free rib (*pl* 3), is 2 inches 2 lines in length; the tubercle, or upper head, is 10 lines long; the breadth of the rib at the point of bifurcation is 1 inch 1 line; the entire length of this rib is $5\frac{1}{2}$ inches. The neck of the fourth rib (*pl* 4) has the same length as that of the third, but is twice as thick and strong; the tubercle is broader but shorter. Beyond the tubercle the shaft of the rib is bent at nearly right angles with the neck. This soon begins to shorten, and the shaft of the rib to lengthen, until it becomes attached solely to the diapophysis.

In the dorsal vertebræ the body increases in all its proportions, excepting its length. The lateral compression now manifests itself at the upper part of the centrum, just below the neurapophysial suture; the under surface of the posterior dorsal and lumbar vertebræ is convex transversely, but in a less degree than in the Megalosaurus, and in some it is obscurely carinated. The external surface at the middle contracted part of the vertebra is moderately smooth, but the minute striæ give it a somewhat silky lustre; it is longitudinally but irregularly ridged and grooved near the articular ends. These are both slightly concave at the centre, more slightly convex near the circumference.

The difference between the vertebræ of the Hylæosaur and the biconcave Crocodilian vertebræ is chiefly manifested in the development of the neural arch. The modification of this part in the cervical vertebræ has already been mentioned. In the dorsal vertebræ (T. VIII, fig. 10) each neurapophysis rises vertically, contracting in

the axis of the vertebra, expanding transversely or outwardly, until it has attained a height equal to that of the centrum; there it expands into a broad and flat platform (*d*), from the middle line of which the broad spine (*ns*) is developed. A vertically compressed but strong diapophysis (*d*) is developed from the side of the neurapophysis, and is supported by a pyramidal underprop (*t*), extending upwards and outwards from the anchylosed base of the neurapophysis. There is a large deep and smooth depression (*p*) on each side of the base of the diapophysis. The anterior surface of the neural arch, above the anterior oblique processes, or prezygapophyses (*z*), is traversed by a vertical ridge, on each side of which there is a shallow depression.* The spinous process (*ns*) is of unusual thickness; its transverse breadth at the base measures 1 inch: this modification may probably relate to the support of great dermal spines. The spinal canal in the dorsal vertebræ is cylindrical, and expanded at both extremities; its diameter at the middle is 7 lines, at the expanded outlets 10 lines, in a posterior dorsal or lumbar vertebra. Here the bases of the neurapophyses begin to shorten, and leave a small proportion of the upper surface of the centrum uncovered at both ends, chiefly at the posterior end.

The following are dimensions taken from three of the vertebræ in the portion of the skeleton of the Hylæosaurus (T. IV):

| | Vertebra No. 4. | | Vertebra No. 6. | | Middle dorsal. | |
|---|---|---|---|---|---|---|
| | In. | Lin. | In. | Lin. | In. | Lin. |
| Antero-posterior diameter of centrum . . | 1 | 10 | 2 | 2 | 2 | 9 |
| Vertical diameter of its articular end . . | 0 | 0 | 1 | 6 | 2 | 6 |
| Transverse diameter of its articular end . . | 2 | 0 | 2 | 2 | 3 | 0 |
| Transverse diameter of middle of centrum . . | 0 | 0 | 0 | 0 | 2 | 0 |

The differences between the vertebræ of the Hylæosaurus and Megalosaurus have been already pointed out, and are further shown in the admeasurements given above. The vertebræ of the Hylæosaurus differ from those of the Iguanodon in their greater transverse diameter, and in the breadth of their under part; those of the Iguanodon are flatter vertically along their whole sides, which converge to a narrower ridge at the under part. The vertebræ of the Hylæosaurus differ from those of the Streptospondylus in the sub-biconcave character of the articular ends of the centrum, and in its comparative shortness and thickness. The separated neural arch might be distinguished from that of the Streptospondylus by the simplicity of the supporting buttress of the transverse process; and, although equal in height, yet is superior in the expansion and strength of the platform and spinous process. From the vertebræ of the Poikilopleuron, an oolitic Saurian of about the same bulk, those of the Hylæosaurus differ in their more compact osseous structure, and in the absence of the large cells that characterise that structure in the vertebral bodies of the Poikilopleuron.

* This description is taken from Nos. 2586 and 2125 parts of the same vertebra in the British Museum.

### *The Sacrum* (T. V and VI).

There is a portion of a sacrum of a small or young Dinosaur (T. VI, figs. 1 and 2, No. $\frac{A84}{24884}$, British Museum), which, in the form and proportions of the bodies of the vertebræ, most resembles the present genus, and cannot be referred to either the Megalosaurus or Iguanodon. It includes two entire and parts of two other vertebral bodies, anchylosed together, and to the bases of the neurapophyses, which, as in the Megalosaurus, are transferred to the upper and lateral parts of the interspaces of the subjacent bodies. These are moderately, but regularly, contracted in the middle and chiefly laterally, being more flattened below, where likewise each is traversed by a longitudinal sulcus. At the middle of each lateral concavity there is a vascular perforation. I am uncertain which is the anterior part of this interesting series; but, by the analogy of the Megalosaurus, conclude that vertebra which supports the greatest proportion of its neural arch to be posterior to the adjoining one which supports the remaining small proportion. On this basis also I assume that the anterior sacral vertebra is deficient, if we may allow five to the Hylæosaur as to the other Dinosaurs.

The second sacral vertebra, then, is here broken across the middle of the body, exposing its solid minutely cellular central structure: its neural arch is too mutilated for profitable description: its base rests nearly equally on the second and third sacral bodies. The third neural arch, which exhibits a similar relative position, has its base extended half way down the vertebral interspace; its strong transverse process, diapophysis and pleurapophysis combined, extends outwards and forwards, and is at first contracted, then expands both transversely and vertically, most so in the latter direction, and is twisted obliquely, so that the lower end is directed downwards and forwards, and the upper and thicker end is bent obliquely backwards, until it meets and becomes anchylosed to the anterior production of the transverse process of the next vertebra behind: an elliptical space is thus produced, the axis of which is nearly vertical, and into this space the neural canal opens; the nerve being transmitted over the middle of the body of the vertebra, as in the sacrum of the Megalosaurus and Iguanodon.

The upper and inner part of the base of the broad, oblique transverse process, or sacral rib, abuts against the base of the spinous process. There is no appearance of accessory spines or metapophyses, such as the sacrum of the Megalosaurus is complicated with.

The following are admeasurements of the present portion of the sacrum of the Hylæosaurus:

| | In. | Lin. |
|---|---|---|
| Length of the body of the third vertebra | 2 | 0 |
| Breadth of its articular end | 2 | 0 |
| Breadth of its middle part | 1 | 4 |
| Breadth of its inferior groove | 0 | 4 |
| Length of the transverse process | 1 | 10 |
| Antero-posterior diameter of the middle of process | 0 | 4 |
| Vertical diameter of base of process | 1 | 6 |
| Vertical diameter of expanded extremity | 3 | 0 |
| From the lower part of centrum to the origin of the spinous process | 2 | 6 |

The spines appear to be anchylosed into a continuous ridge. The anterior surface of the transverse process appears undulated by wide shallow depressions and intervening elevations.

The authors of a paper in the 'Philosophical Transactions' for 1849, who preceded me in the publication of the figures of the sacrum of the Iguanodon, first discovered by me in the collection of the late Mr. Saull, and described in my 'Report on British Fossil Reptiles,'* state that "the sacral fragment referred to the Hylæosaurus by Professor Owen cannot at present be found."

The fragment in question is the one above described. It has never, according to my observation, been absent from its place in the Hylæosaurian series of the British Museum, where it still bears the ticket and numbers, $\frac{484}{2484}$, under which its nature was first made known.†

In the paper in the 'Phil. Trans.,' above cited, the four confluent sacral vertebræ (T. V) are figured as "belonging either to the Hylæosaurus or Iguanodon" (p. 301). The apparent inability to recognise the specimen of Hylæosaurian sacrum, No. 2484, by comparison with which the sacrum (T. V) might have been determined, left the authors in the above state of doubt; yet the unequivocal Iguanodon's sacrum in Mr. Saull's museum suffices to differentiate the present specimen. It consists of the confluent bodies of four sacral vertebræ, answering to those marked *s* 2, *s* 3, *s* 4, and *s* 5, in T. III of my 'Monograph on the Iguanodon.'

The body of the second sacral vertebræ of the Hylæosaurus (T. V, 2) is carinate below, as in the Iguanodon. Above it is smoothly excavated to form the floor of a capacious neural canal (fig. 1, *n*), whence the nerves escaped, passing over the centrum, in consequence of the blocking up of the vertebral interspace by the articulation there of the shifted neural arch.

The third sacral vertebra (3) is not carinate below, as in the Iguanodon, but grooved along the middle line, and the increase of breadth is relatively greater in the centrum.

* 'Reports of the British Association,' volume of 1842, pp. 129—131. † Ib., pp. 113, 114.

This increase is still more marked in the fourth sacral vertebra (fig. 4), which is also longitudinally, but more widely, channelled along its under surface.

The breadth, as compared with the length, increases in the fifth sacral vertebra (5), shown to be the last, as in the Iguanodon, by the terminal articular surface for the first caudal vertebra. Like the preceding centrums, that of the fifth sacral vertebra in the Hylæosaurus is relatively broader and flatter below than in the Iguanodon: but the lateral compression beneath the wide outlets for the nerves, usually intervertebral in position in other reptiles, is well marked. These outlets are relatively wider in the Hylæosaurus than in the Iguanodon, and probably indicate greater activity, and a swifter rate of motion, in the smaller herbivorous Dinosaur.

The base of the pleurapophysis or rib-element—taking the place and function of an inferior transverse process in the Dinosaurian sacrum—may be discerned, wedged into the interspace between the second and third sacral vertebræ at *pl* 3, and again between the third and fourth vertebræ, at *pl* 4, fig. 2, T. V.

A third portion of the sacrum of the Hylæosaurus, which escaped the cognizance of the authors of the paper in the 'Philosophical Transactions' for 1849, is the specimen No. 28,936, British Museum. This consists of the third sacral vertebra, with part of the second and fourth anchylosed therewith, a great proportion of the neural arch, and a small part of the left ilium being included in this very instructive specimen. It is from the submerged Wealden of the Isle of Wight, and has been subject, like many of the fossils from that locality, to a certain degree of attrition by sea-waves on the beach.

The pleurapophysis (fig. 3, *pl* 3), continued from the obliterated interspace between the third and second vertebræ, quickly assumes the form of a broad and high plate, compressed from before backwards, and again becoming thickened when it abuts against the ilium (62).

The diapophysis (fig. 4, *d* 3), arising from the side of the neural arch, seems to form the upper part of the same broad, vertical, transverse wall of bone; but the suture between the pleurapophysial and diapophysial elements of this wall is clearly traceable, extending from the base of the neurapophysis upwards and outwards. The diapophysis at its upper part expands, and seems to bifurcate or abut against the side of the base of the neural spine. This spine forms, at the part of the sacrum here described, a continuous ridge of bone.

The fractured outer border of the ilium has been rounded and water-worn to its present form, which must not be taken as indicating its natural one. A large vacuity was bounded by the ilium and the two contiguous diapophysial plates (fig. 3), as in the sacrum of the Iguanodon: the large nerve-outlet, formed by the receding borders of contiguous neural arches, and the middle part of the centrum, opens into the large space above defined.

*Caudal Vertebræ.* T. X.

A proportion of the tail, to the extent of nearly six feet, and including about twenty-six vertebræ, discovered in a quarry in Tilgate Forest in the year 1837, is preserved in the British Museum (T. X). The diapophyses (*d*, *d*) present almost Crocodilian proportions, in regard to their length, at the interior part of this series, and may be discerned, though diminished to mere rudiments, in the small terminal vertebræ of the series. In the most perfect of the anterior vertebræ they are compressed vertically, but with convex, not flattened sides, and rounded edges, presenting an elliptical transverse section, and preserving the same breadth to their truncated extremity: they extend outwards, and are slightly bent forwards: the breadth of this vertebra between the extremities of the transverse processes is 11 inches. The neurapophysis is curved forwards from the base of the diapophysis to form the prezygapophysis, or anterior oblique process: its length from the extremity of this process to that of the posterior one is $3\frac{1}{2}$ inches. The neurapophysis presents a simple convex external surface up to the base of the neural spine; the antero-posterior extent of this process is 2 inches. The hæmal arches are from 4 to 5 inches in length near the base of the tail (figs. 3 and 4); they may be distinguished, like the diapophyses, by their convex external surface; their bases come into contact, as shown in fig. 4, but are not confluent as in the Iguanodon; they articulate to two separate hypapophyses. Between the pairs of these tubercles, which are placed at each end of the under surface of the centrum, there is a longitudinal sulcus. The diapophyses soon lose the slight anterior curve, stand straight out, decrease in length, and descend from the neurapophysis to the centrum as the vertebræ approach the end of the tail.

The hæmal arches also decrease in length, but they expand in the antero-posterior direction at their unattached and dependent extremity, which is defined by a slight convex outline. Fig. 4 shows the modification of the under surface of the caudal vertebræ, at the middle of the tail; and fig. 5 gives a side view of one of the hæmal arches from this part, of the natural size. The following admeasurements give the rate of decrease in length in the caudal vertebræ, taken at intervals of six joints:

| | In. | Lin. |
|---|---|---|
| Length of body of presumed 8th caudal . . . . . | 2 | 6 |
| Length of body of presumed 14th caudal . . . . . | 2 | 4 |
| Length of body of presumed 20th caudal . . . . . | 2 | 2 |

The sides of the slender posterior vertebræ are distinguished by a slight median expansion below the base of the rudimental transverse process, so that the surface, instead of being gently concave lengthwise, undulates by virtue of the middle elevation.

I have not met with this character in the corresponding vertebræ of other Saurians. In the vertical direction the sides of the centrum in the posterior caudals converge at almost a right angle to the inferior groove. The greater breadth of the centrum, in proportion to its height, may still be discerned in the terminal caudal vertebræ (fig. 6): thus in the centrum 2 inches 2 lines long, the breadth was 1 inch 10 lines, and the height only 1 inch 3 lines. Here the bases of the short, but fore-and-aft extended, hæmapophyses appear to be confluent, as in fig. 7; but their peculiar shape would serve to distinguish them from a hæmal arch of an Iguanodon.

*Bones of the Extremities.—Scapular arch.*

The scapula of the Hylæosaurus (T. IV, 51) is longer and narrower than in the Monitors and Iguanas, adhering in this respect to the Crocodilian type, but most resembling in the shape of its blade or body, that of the genus Scincus. It differs, however, from the scapulæ of all known reptiles, and indicates an approach to the Mammalian type, by the production of a strong obtuse acromial ridge, separated by a deep and wide groove from the humeral and coracoid articular surfaces. The blade of the scapula is long, flattened, slightly convex on the inner and proportionally concave on the outer surface: the anterior margin is convex, the posterior one concave; the upper extremity or base truncate, slightly convex, with the posterior angle a little produced, the anterior angle rounded off. On the outer side of the scapula two broad convex ridges descend and converge to form the beginning of a thick and strong spine, at fourteen inches distance from the base; this then expands into the thick acromial ridge, which extends transversely, and is continued forwards as a long subprismatic process from the anterior angle of the head of the scapula. This process, the homologue of which exists in the scapula of the Iguanodon, and more developed in that of the Megalosaurus, is broken off in the present specimen about four inches from the neck of the scapula, with which it forms a right angle. The acromion is perforated at the base of its anterior prolongation by a foramen analogous to the supraspinal one in the scapula of the Edentate Mammalia. Besides the scapulæ preserved in the connected part of the skeleton, there is, in the Mantellian Museum, a nearly entire and detached scapula of larger size, discovered, in connection with many other bones of the skeleton, in a layer of blue clay near Bolney, in Sussex, and indicating the connected part of the skeleton first discovered in 1832 to have belonged to an immature individual. The dimensions of this scapula are as follows:

| | In. | Lin. |
|---|---|---|
| Length of the scapula | 18 | 0 |
| Breadth of its base | 8 | 0 |
| Breadth of its neck | 3 | 9 |
| Thickness of its base | 1 | 0 |
| Thickness of its neck | 2 | 6 |
| Breadth of subacromial groove | 2 | 0 |
| Breadth of humeral articulation | 4 | 0 |
| Breadth of coracoid articulation | 2 | 6 |

The *coracoids* (T. IV, 52) present a much more simple form than in the Megalosaurus, and resemble those of the Scink and Chameleon, thus deviating in their great breadth, like the coracoids of the Enaliosaurs, from the Crocodilian type. In the portion of the skeleton the right coracoid is slightly bent out of place and thrust under the left one; and there is no trace of a sternal or entosternal bone in their interspace. The median margin of the coracoid describes an uninterrupted and full convex curve commencing at the angle dividing it from the scapular articular surface; but it is separated by a concavity or emargination from the articular surface for the humerus. It is perforated by a moderate-sized elliptical canal, about two inches from the humeral articulation, and in this respect resembles the same bone in the Iguana, Monitors, and Lizards, and differs from that in the Scinks and Chameleons. The antero-posterior extent of the coracoid in the connected portion of the skeleton (T. IV) is 8 inches; its transverse diameter 5 inches.

### *Tibia of the Hylæosaurus.* T. VII.

One of the long bones of a limb, with a phalangeal bone, and a scapula, of the Hylæosaurus, were discovered in a quarry of Wealden stone at Bolney, in Sussex.

The long-bone is figured by Dr. Mantell as a humerus.* It bears a much closer resemblance to the tibia of the Megalosaurus,† but it is shorter and more expanded at its distal end in proportion to its length.

The proximal end (T. VII, fig. 3), which is $6\frac{1}{2}$ inches by $3\frac{1}{2}$ inches in its long and short diameters, shows a median tuberosity (*a*), divided by a depression from a second smaller tuberosity (*b*) (this has been crushed in the specimen), which have articulated with the condyles of the femur. Anterior and external to these the proximal end of the bone is produced into a strong "procnemial" ridge (*c*), the front surface of which is roughened for the insertion of a strong ligament. The shaft of the bone rapidly contracts to a trihedral form, with the angles rounded off; then as rapidly expands, and becomes, as it were, flattened out; more especially by the production of the outer

* 'Philosophical Transactions,' part ii, 1841.

† Monograph, 1856, T. IX.

border (*f*), which shows a broad and shallow articular depression for the distal end of the fibula. The distal articular surface for the tarsus presents the same form of an oblique, wide, and shallow notch (*e*), as in the Megalosaurus.

The largest diameter of this end of the bone is 7 inches; the circumference of the middle of the shaft is 7 inches. At the back part of the shaft, five inches from the proximal end, is the orifice of a canal for the medullary artery, which passes obliquely downwards. The entire length of the bone is 16 inches.

### *Metapodium of the Hylæosaurus.* T. XI.

The specimen, No. 2556, in the British Museum, figured in T. XI, exhibits three metacarpal or metatarsal bones of the same foot, cemented, as naturally connected, by the Wealden matrix. The shape of the outer (IV) and inner (II) of these bones indicates that three alone constituted their segment of the foot, unless some styliform rudiment may have existed, which has left no mark of junction with the next fully developed metapodial* bone.

Those bones of the foot of the Iguanodon, described in a former part of the present Monograph, and figured in T. I, II, and III, afford a means of comparison with the present specimen, and show that it cannot belong to the corresponding foot of the Iguanodon, and that it is very improbable that it can belong to another (fore or hind) foot of the same species. It plainly indicates a foot of longer and more slender proportions, with a different configuration of the metapodial bones. The relative lengths of these bones show that they belong to a foot of the same side of the body as that of the Iguanodon above described.

The proximal ends of the three bones have been broken off obliquely, the outermost (T. XI, II) retaining the greatest proportion of the shaft: the innermost (ib., IV) retains its distal articular surface; the middle bone (ib., III) has a portion of the same surface. The distal end of the outermost bone is broken away.

By the analogy of the metapodium of the Iguanodon, the innermost metapodial of the present specimen answers to the second in the pentadactyle foot, the middle to the third, and the outermost to the fourth. The foot to which they belonged was functionally tridactyle, through the arrest of development or suppression of the first and fifth toes in the pentadactyle foot.

The metapodial (II) has a sub-compressed shaft, convex on the inner or free side (figs. 1 and 2), slightly concave towards the middle metapodial; with the anterior

* The term "metapodium" signifies the same segment in both fore- and hind-feet, and is requisite in treating of such segment when it cannot be determined whether it is of the fore-foot, metacarpus, or of the hind-foot, metatarsus.

margin sharp, but not produced at the middle of the bone, as in the Iguanodon: the distal articular surface is convex at its anterior half, trochlear at its posterior half, or with a median, rather oblique groove between two tuberosities.

The middle metapodial (III) differs from that of the Iguanodon in its uniformly almost flat anterior surface. The outer metapodial (figs. 1 and 3, IV) has a flatter and relatively broader outer surface than in the Iguanodon: the antero-internal border subsides about half way down the shaft: the internal border appears to be produced towards the middle metapodial, as in the Iguanodon. The distal end of the outer metapodial (IV) must have extended lower than that of the inner one.

The size and texture of the above-described bones of the foot accord best with the characters of the osseous texture in the Hylæosaurus, of which they are probably part of the hind-foot.

### *Jaw of the Hylæosaurus?* (T. VIII, figs. 1—5).

No. $\frac{4\,c\,c}{2\,4\,2\,2}$, in the Reptilian Series of the British Museum, is a portion of the right ramus of the lower jaw, with characters distinguishing it from that of any other known Saurian: as, for example, its curvature, indicating the lower jaw to have been bent down in an unusual degree, and the remarkable inequality of its external surface. This fragment is about 3 inches long, 1 inch 7 lines deep at the hind part, and 1 inch 5 lines deep at the fore part; flattened and smooth at the inner side (T. VIII, fig. 2), but having the outer side (fig. 1) raised by the termination of a strong angular ridge at its lower and hinder part, and by a rough convex longitudinal ridge extending along its upper part; the surface of the jaw being concave above and below this ridge. The lower margin is thick and convex; the upper one (fig. 3) is formed by a regular series of pretty close-set sockets, with the internal alveolar wall imperfectly developed, and in part broken away, displaying their partitions; but with the outer wall entire, thin, and slightly crenate at its upper margin (fig. 1).

At the hind part of this fragment (fig. 4) the anterior extremity of the splenial piece is preserved; the rest is formed exclusively by the dentary piece: the area of the wide conical cavity in the interior of the jaw is exposed at the back part of the fragment; its apical termination is near the fore part (fig. 5). A succession of large vascular canals open obliquely forwards in the concavity above the upper oblique longitudinal ridge. The whole of the outer surface is minutely ridged and punctate.

The depth of the sockets bears a smaller proportion to that of the jaw than in modern Lacertians or Crocodiles, being about one fourth of that depth (fig. 2); the partitions of the sockets, which are very regular in their breadth and depth, though they are more prominent than in the pleurodont Lizards, yet exhibit a fractured margin; there is no trace of a smooth natural surface of the bone in the interspace of the sockets;

and at the part where the inner wall has been least mutilated, it nearly completes the socket, and incloses the long and slender fang of the tooth. Whence, I conclude, that the entire jaw of the extinct reptile would have exhibited a series of true sockets, with oblique outlets, not depressions merely, as in the present mutilated fragment; and that it would have agreed with the Megalosaurus in presenting the sub-thecodont mode of implantation of the teeth.

The crowns of all the teeth are broken off; the small sockets of reserve, exposed at the inner side of the base of the old sockets, do not contain any evidence of the species to which this fossil has belonged.

In my 'Odontography,'* I adopted the opinion of Dr. Mantell† respecting the present fossil, viz., that it belonged to a young Iguanodon; but subsequent considerations‡ induced me to refer it to the same species of extinct reptile as the teeth (T. VIII, figs. 6—9) belonged to.

Since the publication of my 'Reports on British Fossil Mammalia,' the lower jaw of the Iguanodon has been discovered, and leaves no room for doubt as to the generic and specific distinction of the present fossil. In the portion of jaw in question (T. VIII, figs. 2 and 3) there are eighteen alveoli in an extent of three inches: in the lower jaw of a young Iguanodon of the same size, there are but nine alveoli in the same longitudinal extent; whilst in three inches of the dentary border of the mandible of an older Iguanodon, there are but four alveoli. The form of the alveoli, as I had inferred from the known shape of the teeth of the Iguanodon, differs from that of the alveoli in the portion of jaw figured in T. VIII; but those alveoli accord with the shape of the fangs of the teeth next to be described.

* Part II, 1839, p. 248. † 'Wonders of Geology,' vol. i, p. 393.

‡ "In the absence of this characteristic part of the tooth, an element in guiding our choice between the Iguanodon and Hylæosaur is given by the breadth of the interspaces of the sockets; these must bear relation to the breadth of the crowns of the teeth, if we suppose that they were in contact throughout the series, as in Lacertians. Now, the teeth of the Iguanodon, and those which I have referred to the Hylæosaur, differ in a marked degree in the breadth of the crown. The complicated and expanded crown of the Iguanodon's tooth is supported on a narrower stem; and the stems or fangs, if the crowns were in contact without overlapping, must have been separated by interspaces of proportional breadth, viz., twice their own breadth; but the thickness of the crown of the tooth of the Iguanodon renders it very unlikely that they did overlap each other. Now, the crowns of the teeth of the Hylæosaur are expanded to such an extent as, if in contact, to require an interspace of the fangs, not broader than the fangs themselves; and the interspaces of the fangs in the fragment of jaw under consideration correspond with crowns of this breadth. The fangs of the teeth in the Iguanodon are conical, and more or less angular; in the teeth presumed to belong to the Hylæosaur the fangs are cylindrical; the sockets in the present fragment correspond with the latter form." (Report on British Fossil Reptilia, in the 'Reports of British Association,' 1841, p. 110.)

*Teeth of the Hylæosaur?* T. VIII, figs. 6—9.

At the period of preparing my 'Report on British Fossil Reptiles,' the teeth of the Hylæosaurus were unknown; but in the quarries where the bones of that reptile had been discovered, a few teeth had been met with of a peculiar form, respecting which Dr. Mantell wrote—"They appear to have belonged to a reptile, and are entirely distinct from those of the Megalosaurus, Iguanodon, Crocodile, and Plesiosaurus, whose remains occur in the Tilgate strata."* The form and structure of these teeth (T. VIII, figs. 6, 7, and 8) deviate too much from those of the Crocodilian family to make at all probable a reference of them to the genera Poikilopleuron, Streptospondylus, or Cetiosaurus, which are much more closely allied to the Crocodilians than is the *Hylæosaurus*. In a later work,† Dr. Mantell attributes these teeth, on the authority of M. Boué, to the Cylindricodon, a name by which Dr. Jäger distinguishes one of the species of his genus "Phytosaurus." I have been favoured by Dr. Jäger with one of the bodies supposed to be the teeth of the Cylindricodon of the Wirtemberg Keuper, but it is merely the cast of a cylindrical cavity, consisting entirely of that mineral substance, without a trace of dental structure. The difference of form between the Wealden teeth now under consideration, and those on which the *Phytosaurus cylindricodon* of Jäger was founded, is pointed out in detail in my 'Odontography,'‡ and has been likewise appreciated by the estimable palæontologist, M. Fischer de Waldheim, by whom their resemblance to certain Saurian teeth from the Ural Mountains, belonging to the genus Rhopalodon, is indicated. From these teeth, however, the presumed Hylæosaurian teeth differ in having thick and flat instead of serrated coronal margins.

The fang of the tooth is subcylindrical, subelongate, smooth; as it approaches the crown it diminishes in one diameter, and slightly and gradually expands in the opposite diameter, forming a sub-compressed, slightly incurved crown, with the borders straight and converging at a moderately acute angle to the apex. These borders, in most specimens, are more or less worn, indicating the teeth of the opposite jaws to have been placed alternately, so as to meet and reciprocally occupy the angular vacuities left by the sloping borders of the crown: the enamel at these borders being worn away, and the dentine exposed.

The following is the result of a microscopical examination of these teeth. The tooth consists of a body of dentine covered by a thick coating of clear enamel, with minute superficial longitudinal striæ, and surrounding a small central column of osteo-

* 'Wonders of Geology,' vol. i, p. 403.

† 'Geology of the South-east of England,' p. 293.

‡ P. 196.

dentine, consisting of the calcified remains of the pulp. The dentine differs, like that of existing Lacertians, from the dentine of the Iguanodon in the entire absence of the numerous medullary canals which form so striking a characteristic of the more gigantic Wealden reptile. The main dentinal tubes are characterised by the slight degree of their primary inflections; they are continued in an unusually direct course from the pulp-cavity to the outer surface of the dentine, at nearly right angles with that surface, but slightly inclined towards the expanded summit of the tooth. They are chiefly remarkable for the large relative size of their secondary branches, which diverge from the trunks in irregular and broken curves, the concavity being always towards the pulp-cavity. In most parts of the tooth, the number of these branches obscures even the thinnest sections.

The ossified pulp exhibits the parallel concentric layers of the ossified matter surrounding slender medullary canals, and interspersed with irregular elliptical radiated cells, affording the usual characters of the texture of the bone in the higher reptiles.

From the form and structure of these teeth, it may be inferred that they have belonged to a Dinosaurian reptile; not so strictly phytiphagous as in the Iguanodon, but probably having a mixed diet.

In reference to the size of both the fragment of jaw and of the teeth, there is about the same proportion between them and the known remains of the Hylæosaurus, as between the jaw with teeth of the Iguanodon and the vertebræ and limb-bones of that colossal Dinosaur. The structure of the osseous substance of the portion of jaw figured in T. VIII closely accords with that of the known bones of the Hylæosaurus.

Having, therefore, demonstrated that the above-described mandibular and dental fossils of the Wealden do not appertain to the Iguanodon, nor to the Cylindricodon, it has appeared to me more to the interests of palæontology to refrain from adding to its catalogues a new name, which at present could signify nothing but the bare possibility that the grounds for approximating the fossils in question to the Hylæosaurus may prove not to be valid.

### *Dermal Scutes.* T. X.

Unequivocal evidence that a dermal skeleton, analogous to that in the recent Crocodiles, was developed in the Hylæosaurus, has been afforded by the discovery of bony scutes in the mass of petrified vegetable matter removed in clearing the portion of the skeleton first described. Some of these detached bony plates still adhere to the caudal vertebræ, and may be observed to decrease in size as they approach the end of the tail (T. X, fig. 1, *i*, *i*). From their form, which is elliptical or circular, and from the

absence of any surface indicating the overlapping of an adjoining scute, it may be inferred that the bony plates in question studded in an unconnected order the skin of the Hylæosaur. The diameter of the largest of these scutes does not exceed 3 inches; the smallest present a diameter of 1 inch. They are flat on the under surface, convex with the summit developed into a tubercle in the smaller specimens, but which is less prominent in the larger ones: the outer surface is studded all over by very small tubercles: the inner surface presents the fine decussating straight lines, which I have described as characterising that surface, in the scutes of the Goniopholis.*

By the kindness of Dr. Mantell, I was favoured, when preparing my 'Report on Fossil Reptiles,' in 1840, with the means of submitting the structure of a dermal scute of the Hylæosaur to microscopical examination. This structure is represented in T. IX, fig. 1, and was described in my 'Report' as follows:

"The medullary canals, which are stained brown, as if with the hematosine of the old reptile, differ from those of ordinary bone in the paucity or absence of concentric layers. They are situated in the interspaces of straight, opaque, decussated filaments, which frequently seem to be cut short off close to the medullary canals. Very fine lines may be observed to radiate from some of the medullary canals: irregularly shaped, oblong, and angular radiated cells are scattered through most parts of the osseous tissue, but they present less uniformity of size than do the Purkinjian cells in ordinary bone. The most striking characteristics of the dermal bone are the long, straight, spicular fibres which traverse it, and decussate each other in all directions, representing, as it seems, the ossified ligamentous fibres of the original corium."†

### *Dermal Spines?* T. IX.

On the left side of the thorax, partly overlying the left scapula and vertebral ribs in the large slab of stone containing the anterior part of the skeleton, now in the British Museum, there are some large elongated, flattened, pointed plates of bone, three of which seem to follow each other in natural succession (T. IV, *d*, *d*, *d*). The length of the first of these plates is 17 inches, the breadth of the base 5 inches, equal to the antero-posterior diameter of two vertebræ: they decrease somewhat rapidly in length, the second being 14 inches long, and the third 11 inches long; but they slightly increase in breadth.

These remarkable bones were regarded by Dr. Mantell‡ as having formed part of a serrated fringe extended along the back of the animal, analogous to that of the Cyclura

* 'Reports of British Association,' 1841, p. 71.

† Ib., p. 115.

‡ 'Geology of the South-east of England,' p. 323; 'Wonders of Geology,' vol. i, p. 402.

Lizard. The chief objection, though not decisive, against this view is, a want of symmetry in the form of the most perfect of them. They are nearly flat, but along the middle present a slight degree of concavity towards the observer, which, however, I once thought "might be paralleled by a similar concavity on the oposite side buried in the stone;"* but a separate specimen since obtained proves that side to have been convex (T. IX, fig. 3); and the anterior margin in the bones (*d*, *d*, T. IV) inclines from the middle line towards the concave side.

With regard to their relative position to the rest of the skeleton, it must be remembered that the ventral surface of this is exposed (T. IV); so that the under parts of the bodies of the vertebræ are towards the observer, and their spines imbedded in the matrix. The coracoids (52) and scapulæ (51) are placed, as might be expected in a skeleton little disturbed and lying on its back, with their under surfaces towards the observer, and covering, like a buckler, a portion of the vertebræ and ribs. In this position we might look for a portion of the apparatus of the sternal or abdominal ribs, in the hope of discerning the modifications of these variable parts which might characterise a genus differing in many peculiarities from other known Saurians. Now it is with the apparatus of abdominal ribs, which present such a diversity of characters in other Saurians, that it may be useful to compare the long flattened bones in question, as well as with the supporting bones of a dorsal crest, in the event of a future discovery of a skeleton or portion of skeleton of the Hylæosaurus including these bones. The objection to their being abdominal ribs, which may be founded on their great relative breadth as compared with those ribs in other Saurians, and especially with the vertebral ribs of the Hylæosaurus itself, deserves due consideration; but the same objection applies to the bones in question as compared with the superadded spines in the Lizard with a dorsal fringe, or with the spines of the vertebræ themselves in the Hylæosaurus. For the dorsal dermal spines in the Cycluar correspond in number with the spines of the vertebræ which support them, while the base of each of the hypothetical dermal spines of the Hylæosaur extends over more than two vertebræ.

In the Monotrematous quadrupeds (*Ornithorhynchus* and *Echidna*) the abdominal ribs are as much broader than the vertebral ribs as they would be in the Hylæosaurus, on the costal hypothesis of the detached bony plates here suggested; and, after the close repetition in the Ichthyosaurus, of another of the remarkable deviations in those aberrant Mammals from the osteological type of their class, viz., in the structure of their sternal and scapular arch, the reappearance of the monotrematous modification of the sternal ribs in the present extinct reptile would not be surprising. The want of symmetry and the difference of size and form, above alluded to, in the four succeeding spine-shaped plates, agree better with the costal than the spinous hypothesis.

* 'Reports of British Association,' 1841, p. 116.

Whether the bones in question be dorsal spines or abdominal ribs, they have evidently been displaced from their natural position in the partial disarticulation of the entire skeleton (T. IV) prior to its immersion in the mud that has been subsequently hardened around it; but the degree of displacement has not been greater in the one case than in the other.

In offering, with due diffidence, a choice of opinions respecting the nature of these singular bones, I have been actuated solely with the view of accelerating the acquisition of the true one; which, it is obvious, will be more likely to be attained by the choice being present to the mind of subsequent fortunate discoverers of these remains of the Hylæosaurus, than if they were solely preoccupied by the hypothesis of the dorsal fringe. For example, it may lead to more careful noting of the constancy or otherwise of the unsymmetrical inclination of the convex margin of the spine, and whether they form, or are disposed in, pairs; which, on the costal hypothesis, may be expected, in the event of another skeleton being discovered.

The peculiarly unsymmetrical figure of these problematical bones is strikingly shown in the specimen (T. IX, figs. 2 and 3, No. 28,851) now in the British Museum, discovered in the same quarry in Tilgate Forest, whence the above-described part of the skeleton of the Hylæosaurus was obtained.

It is a long triangular plate of bone (fig. 3), thickened at the base, becoming rapidly compressed or flattened beyond it, and gradually decreasing in thickness and breadth to the apex. Both the apex and one angle of the base have been broken away; but the bone can hardly have been under 8 inches across the base, and 15 inches in total length.

The base is surrounded by a low, obtuse, thick ridge (*a*), and is excavated by an irregular angular depression (*b*), the sides of which extend below or beyond the boundary ridge, at *c* and *d*; these productions not being opposite, but adding to the general oblique and unsymmetrical character of the apparently articular surface.

The body of the bone is moderately convex on one side (T. IX, fig. 3), and correspondingly concave on the opposite side, at the basal two thirds of its extent, beyond which the surface becomes convex transversely, but retaining its longitudinal concavity (fig. 2).

Several coarse vascular canals open upon and groove for a greater or less extent the outer surface of the bone, indicative of the periosteum being connected with a corium producing a thick epidermal covering; and this feature much inclines me to regard the bone as a true dermal spine. On the same hypothesis, the groove between the boundary ridge of the base and the projecting parts of the border of the basal depression, may have served for the implantation of dermal muscles, regulating the position of such spine.

But if these osteodermal spines formed a single series along the mid-ridge of the back, as the purely epidermal spines do in the Cyclura, they must have overlapped each

other, and the unsymmetrical form must have related to such unusual disposition. In the *Xiphosurus velifer* of Cuvier, the fin-like crest along the dorsal aspect of the tail is supported by osseous spines: in the *Lophura* a dorsal crest is similarly supported; but the dermal spines are symmetrical. There remains the hypothesis, that there may have been two series of such spines, projecting one from each side of the dorsal region of the Hylæosaurus.

The shortness of the tibia, and the unusual development of its terminal processes for muscular attachments, indicate great strength of the hind limbs; and the glimpses which we thus obtain of this Wealden Dinosaur convey most strange ideas of its form and habits.

The remains of *Hylæosaurus armatus* have been discovered in the Wealden formation at Battle, Bolney, and Tilgate Forest, Sussex.

TAB. I.

Foot of a young Iguanodon, upper or front view; nat. size.

From the submerged Wealden Beds, South Coast, Isle of Wight. In the Museum of Samuel H. Beccles, Esq., F.G.S.

II
III
I
IV
I
II
II 1
IV
1 IV
1 III
II 2
2 IV
3 IV
4 IV
2 III
II 3
5 IV
3 III
4 III

T. I.

## TAB. II.

Metapodium of a foot of a young Iguanodon, nat. size.

Fig.

1. Proximal articular ends of the three principal bones, II, III, and IV, and of the anchylosed rudimental bone, I.
2. Under or back view of the same bones.
3. Distal articular ends of the three principal bones.

From the submerged Wealden Beds, South Coast, Isle of Wight. In the Museum of Samuel H. Beccles, Esq., F.G.S.

Fig. 1

Fig. 2.

Fig. 3.

T. II.

from Nature on Stone by C. Hullmandel

## TAB. III.

Parts of the foot of a young Iguanodon, nat. size.

Fig.

1. Inner or tibial side view of the second toe, II, with rudiment of the first, I.
2. Inner or tibial side view of the first, second, and third phalanges of the middle toe.
3. Outer or fibular side view of the fourth or outer toe.

From the submerged Wealden Beds, South Coast, Isle of Wight. In the Museum of Samuel H. Beccles, Esq., F.G.S.

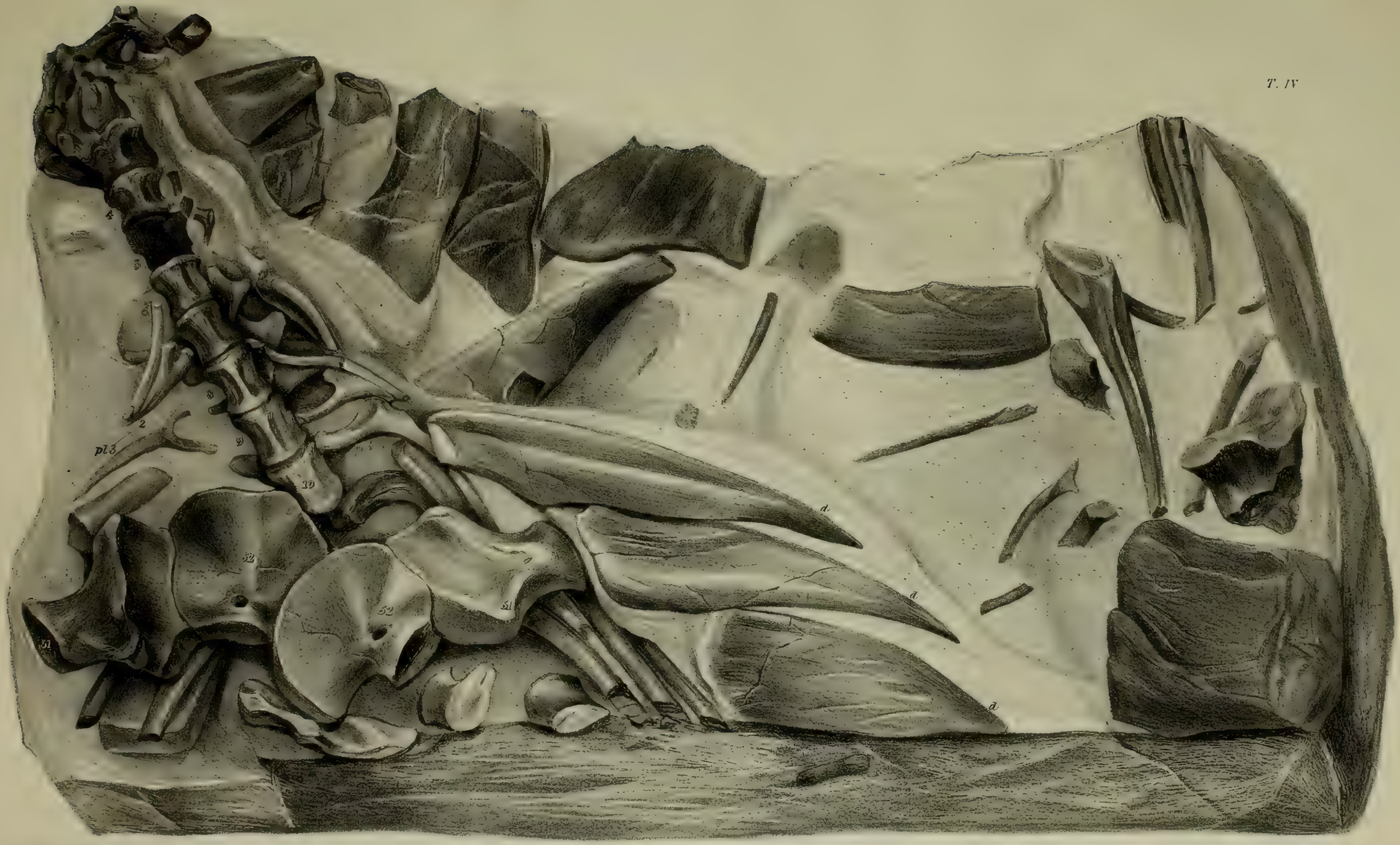
Fig. 3.
Fig. 1.
Fig. 2.
IV
III 1
III. 2
III. 3
IV. 1.
IV. 2.
IV. 3.
IV. 4.
IV. 5.
II
II. 1
II. 2.
II. 3

T. III.

## TAB. IV.

Portion of the skeleton of the Hylæosaurus, one fourth nat. size.

From the Wealden of Tilgate, Sussex. In the British Museum.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51
52
51
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d
d

## TAB. V.

Four anchylosed bodies of sacral vertebræ of a young Hylæosaurus, nat size.

Fig.

1. Oblique side view, showing the expanded neural canal.
2. Under view.

From the Wealden of Tilgate Forest, Sussex. In the Collection of Captain Lambart Brickenden, F.G.S.

Fig. 1.

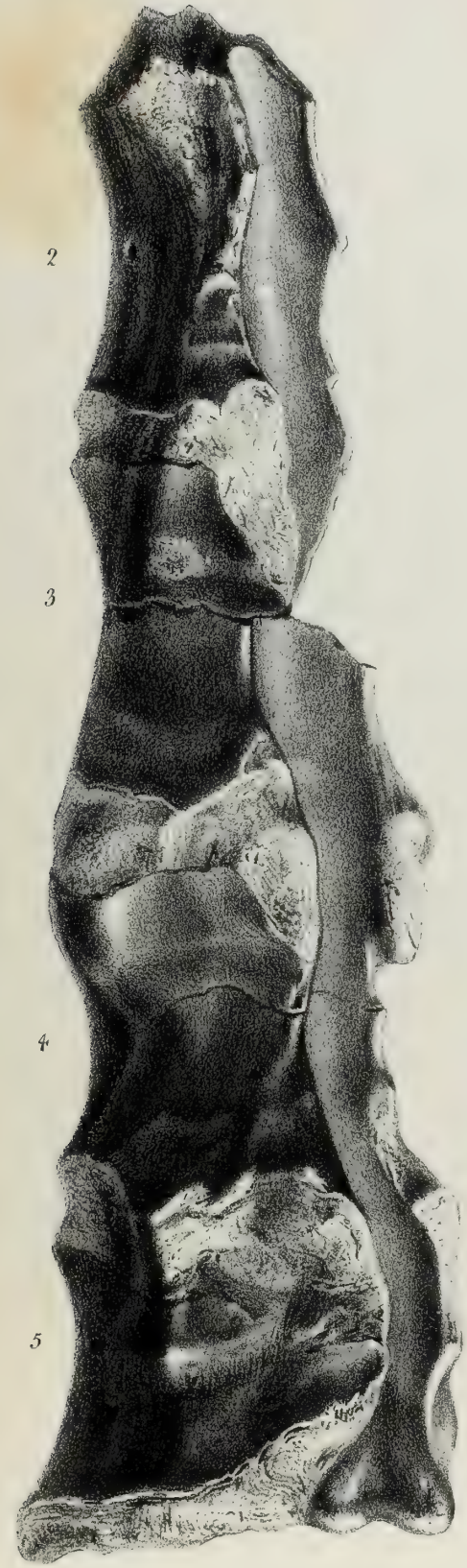


Fig. 2.

Jos Dinkel. lith.

W. West. Imp

## TAB. VI.

Portions of the sacrum of the Hylæosaurus, half nat. size.

Fig.

1. Under view of the third and fourth, with portions of contiguous anchylosed, sacral vertebræ.

   From the Wealden of Tilgate, Sussex. In the British Museum.

2. Side view.
3. Under view.
4. Upper view of the third, with portions of the second and fourth, sacral vertebræ.

   From the submerged Wealden Beds, South Coast, Isle of Wight. In the British Museum.

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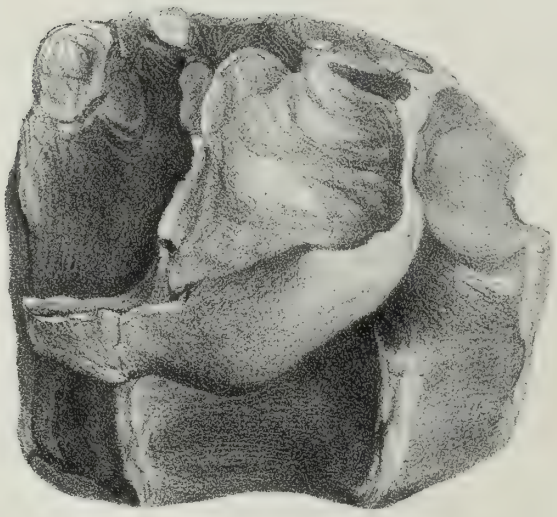

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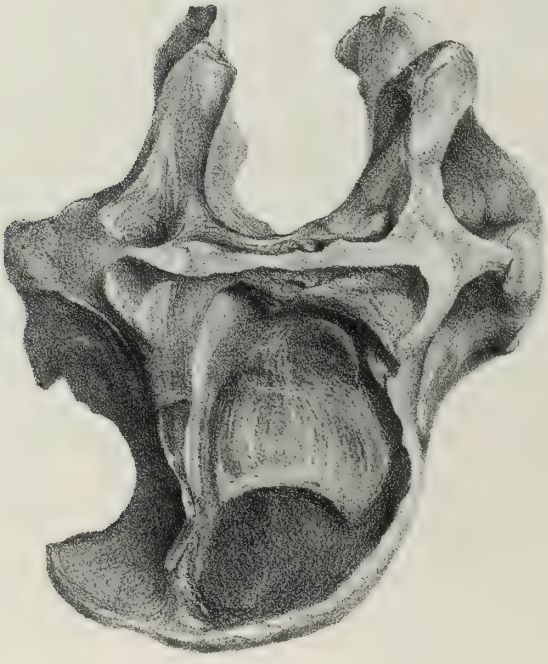


## TAB. VII.

Tibia of the Hylæosaurus, half nat. size.

Fig.

1. Inner side view.
2. Outer side view.
3. Upper articular end.

From the Wealden at Bolney, Sussex. In the British Museum.

Fig.1.

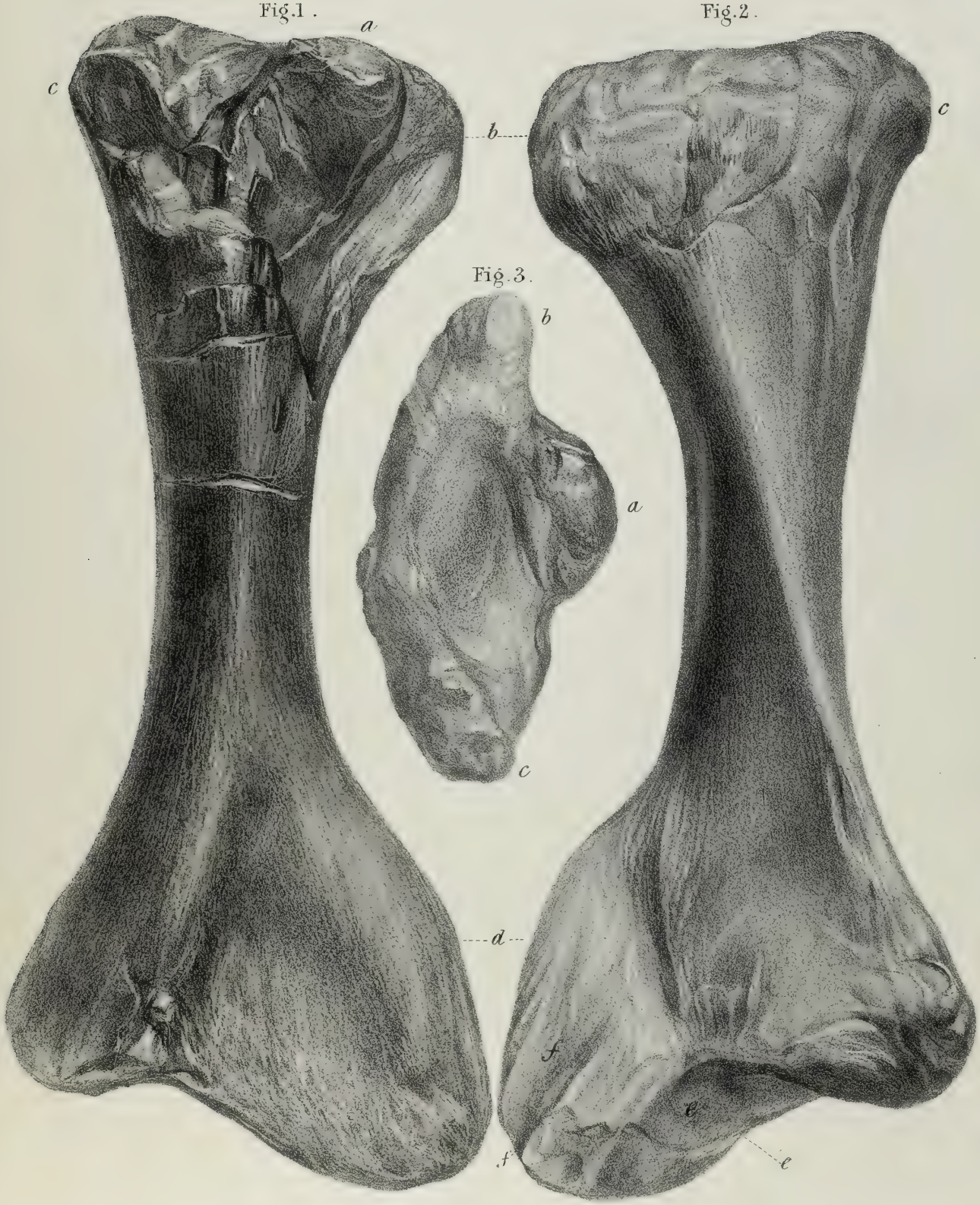



Fig.2.




Fig.3.




½ Nat. size.

## TAB. VIII.

Fig.

1. Outside of a portion of jaw.
2. Inside of the same portion of jaw.
3. Upper view of the same.
4. The hinder fractured end of the same.
5. The fore fractured end of the same.

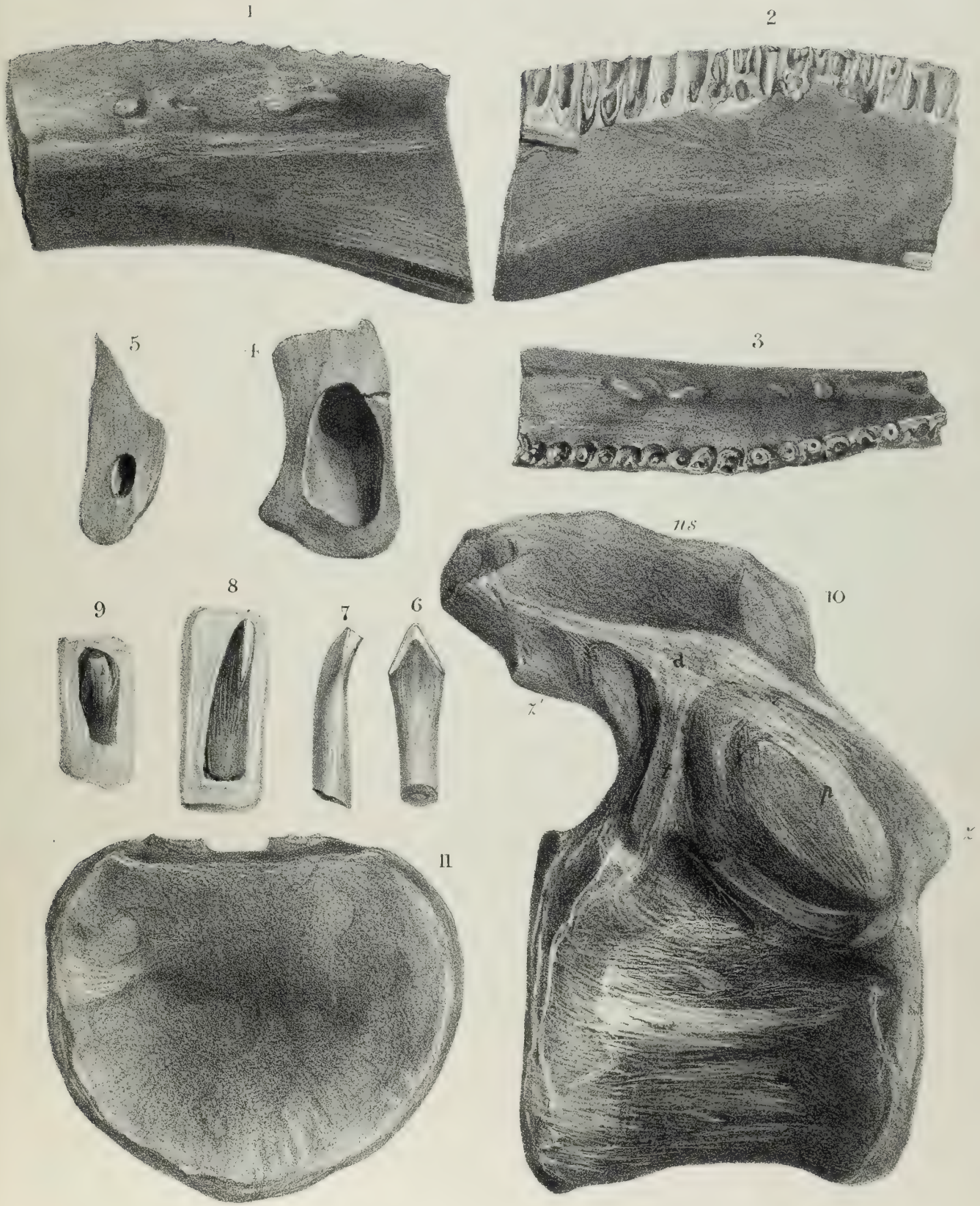
6 and 7. Two views of a tooth.

8. Side view of a tooth, imbedded in Wealden matrix.
9. A portion of a tooth, similarly imbedded.

The above specimens are referred, with probability, to the Hylæosaurus.

10. Side view of a dorsal vertebra of the Hylæosaurus.
11. Articular surface of the body of the same vertebra.

From the Wealden of Tilgate Forest, Sussex. In the British Museum.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## TAB. IX.

The osseous basis of a dermo-neural spine of the Hylæosaurus.

Fig.

1. A section, highly magnified, of the osseous tissue.
2. Hinder border of the spine (reversed).
3. Side view of the spine.

From the Wealden of Tilgate Forest, Sussex. In the British Museum.

Fig. 1.

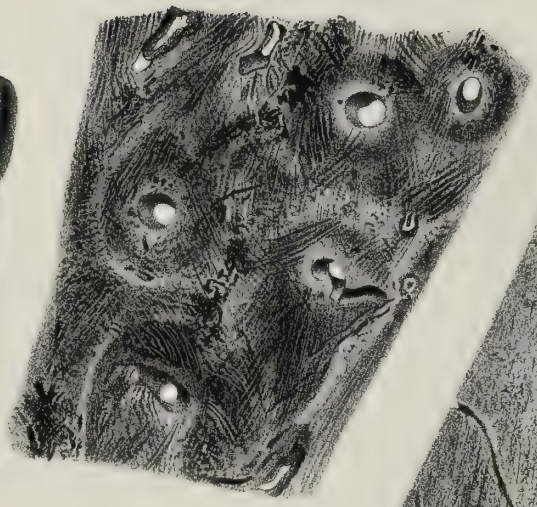


Fig. 2.

Fig. 3.

Dinkel lith

W West Imp

## TAB. X.

Caudal vertebræ of the Hylæosaurus, one sixth nat. size.

Fig.

1. Ten vertebræ from the base of the tail.
2. Eleven vertebræ from near the end of the tail.
3. Under view of anterior caudal vertebræ, showing the form, and place of articulation, of the hæmapophyses.
4. Back view of a hæmal arch from the same (*h*) region of the tail (half nat. size).
4′. Under view of middle caudal vertebræ, showing the shape of the hæmapophyses, *h*.
5. Side view of a hæmal arch from a middle caudal vertebra (half nat. size).
6. Under view of caudal vertebræ beyond the middle of the tail.
7. Back view of a hæmal arch from one of these vertebræ (half nat. size).

The further modification of the hæmapophyses in the posterior caudal vertebræ is shown in fig. 2.

From the Wealden of Tilgate, Sussex. In the British Museum.

Fig. 1

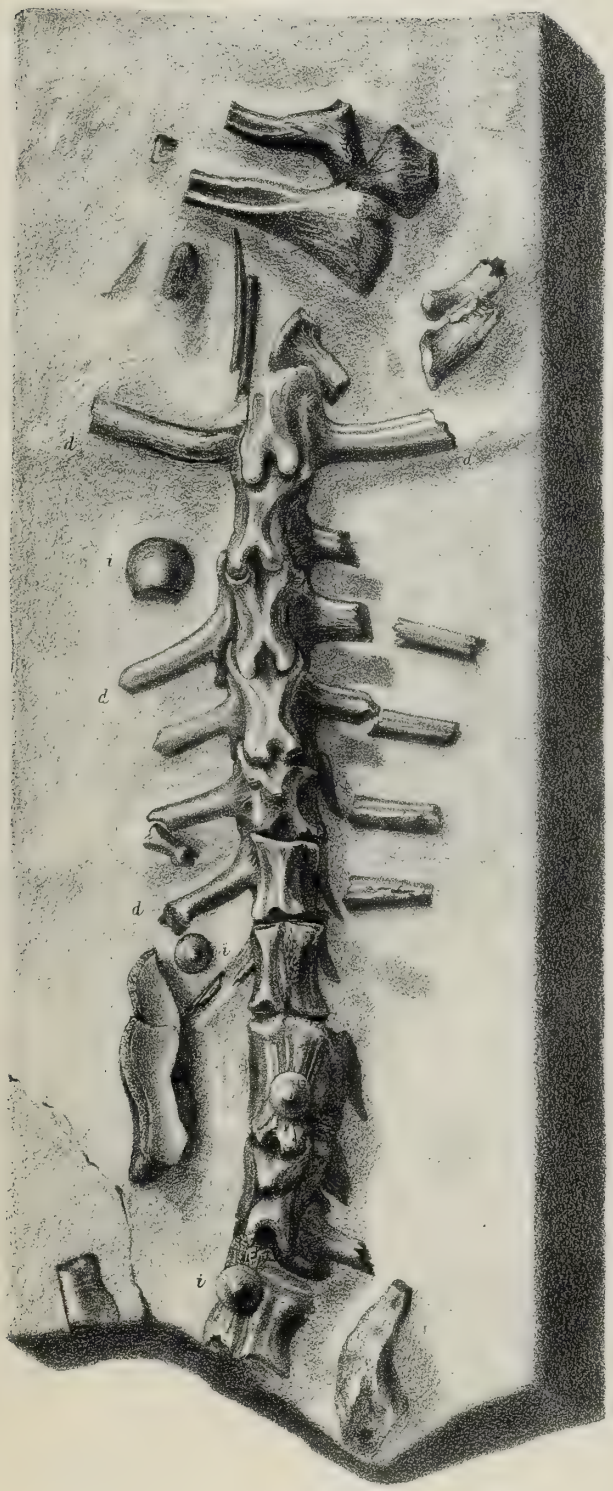



Fig. 2.

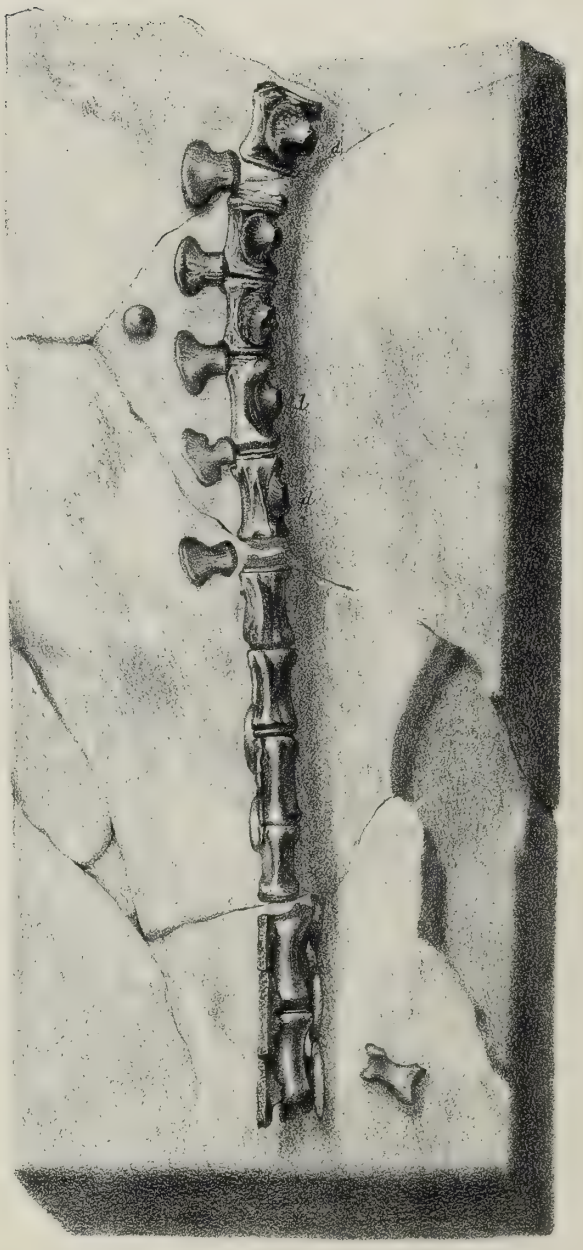



Fig. 5.

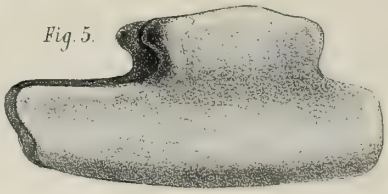
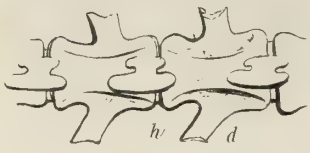


Fig. 7

Fig. 6.

Fig 4



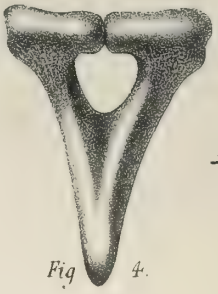



Fig 4.

Fig. 3

## TAB. XI.

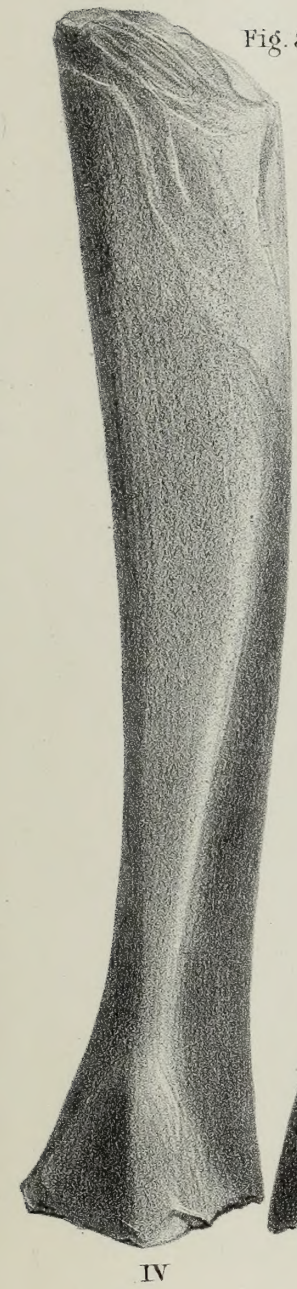
Metapodium of a foot of the Hylæosaurus.

Fig.

1. Front or upper view of the three normally developed metapodials.
2. Tibial side view of the innermost, answering to the second.
3. Fibular side view of the outermost, answering to the fourth.

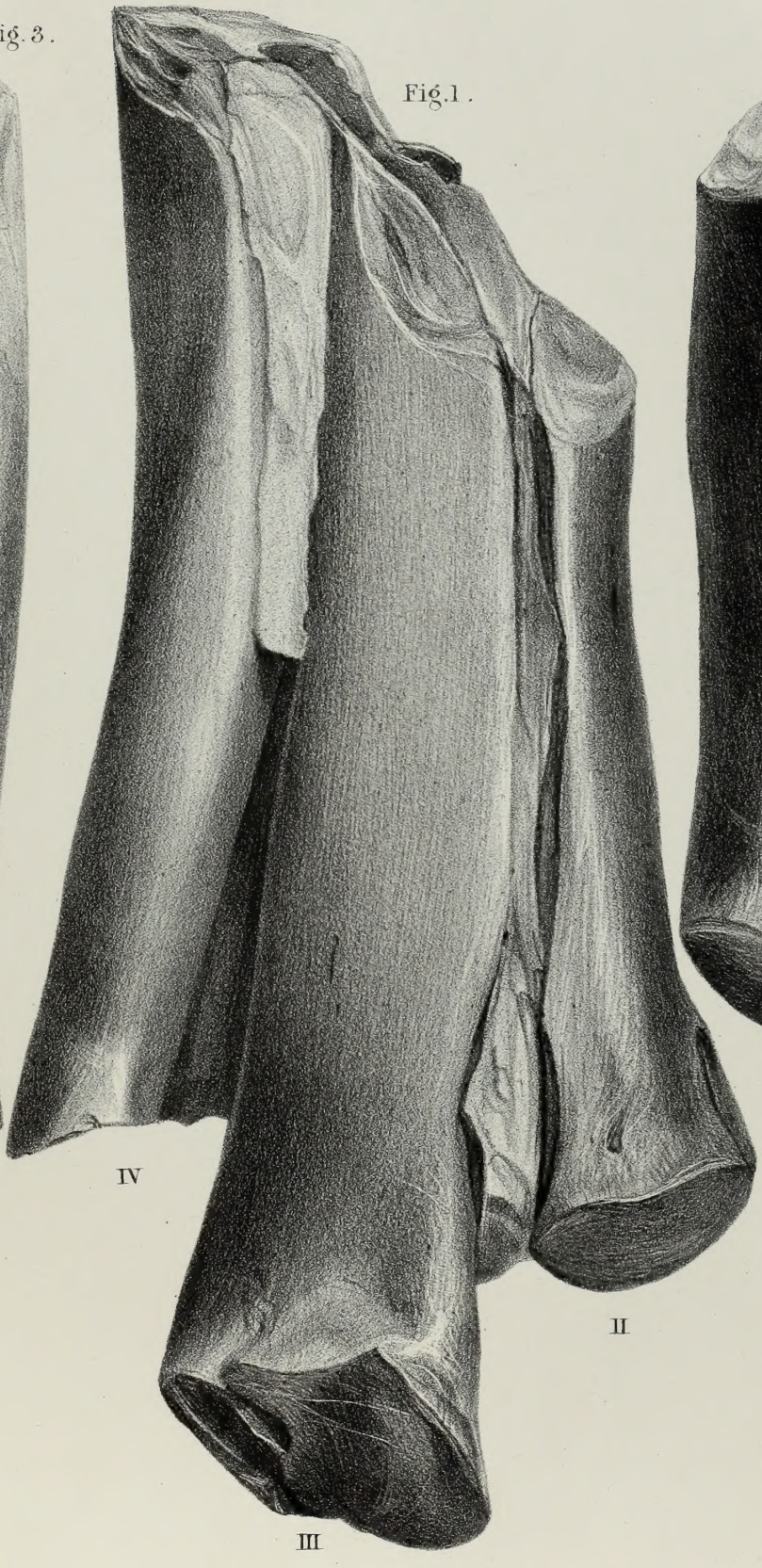
From the Wealden of Tilgate, Sussex. In the British Museum.

Fig. 3.



IV

Fig. 1.

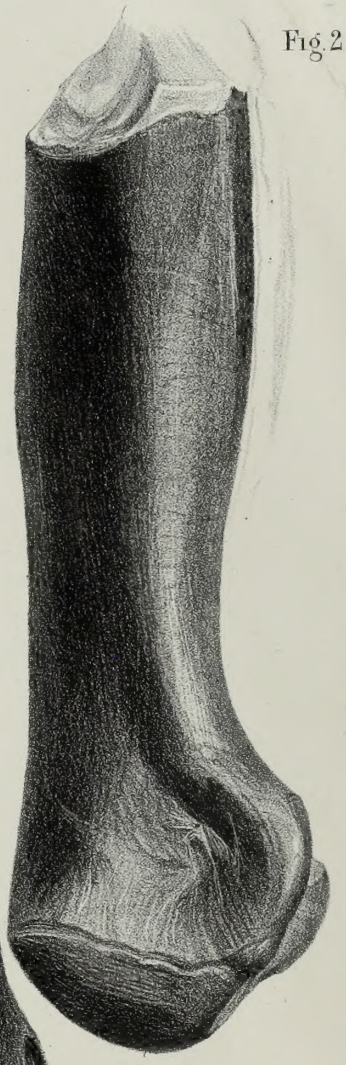


IV

II

III

Fig. 2.



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